EDITORIAL

OIL-BURNING locomotives are being used exclusively on the Grand Trunk Pacific railway from Prince Rupert to Jasper, British Columbia, a distance of 719 miles.

DREDGING the channel near the mouth of the Sacramento river has resulted in increasing the tidal fluctuation at Sacramento from 4 inches a few years ago to 1 foot at the present time. Confining the river below the city has also resulted in scouring out the sand, so that the depth of channel for a given gauge-height has been increased several feet.

RECONSTRUCTION of the branch of the Atchison, Topeka & Santa Fe railroad between Fallbrook and Temecula has been ordered by the California Railroad Commission. The line was washed out in 1891 and has never been rebuilt. It was claimed that the Santa Fe Railroad in acquiring the property of the company that originally built the road, also obligated itself to continue to operate it, particularly since the first company received a large bonus from residents of San Diego county. The reopening of the branch would give a direct line from San Diego to San Bernardino and Eastern points without going through Los Angeles. It is reported that the Santa Fe will appeal from the decision of the Commission, as the maintenance of the line would be so expensive as to preclude all possibility of profit from its operation.

RATINGS of concrete batch mixers are in a fair way to becoming standardized. Heretofore, some manufacturers have based their mixer ratings upon capacity of dry materials. The irrationality of this method will be apparent at once. Others rated the capacity in terms of the wet-mixed batch, which resulted in much confusion in the mind of the user as to what the capacity of a mixer really was. Steps have now been taken to remedy this state of affairs through the action of the National Association of Mixer Manufacturers, which has adopted a resolution providing that all batch-mixers shall be rated upon the basis of their capacity in wet-mixed concrete. The members of the Association have agreed further that wherever dry-batch ratings are used in their catalogues, wet-batch ratings will be given equal prominence.

NOW that the time for the closing of the Panama-Pacific Exposition is drawing near, it is pleasant to note that the directorate has given public recognition to the value of the services of the engineers, to whom in the fullest measure, credit is due for the physical part of the Exposition. Contrary to all precedent, an engineer instead of an architect was appointed Director of the Department of Works. Since engineers are generally regarded as gross materialists, who are apt to give more weight to utilitarian than artistic considerations, many opinions were expressed that since the engineers were in power, the outward aspect of the Exposition would be anything but pleasing to the eye, although perhaps efficient for the purpose and built at a cost within the estimates. It has been conclusively proved, however, that the engineer has been able to work in harmony with the architect, and adapt the esthetic considerations to the economic factors, thereby accomplishing such results as will cause the Panama-Pacific Exposition to go down into history, not merely as the most beautiful of all Expositions, but as one that was built within the original estimates of cost. This latter consideration was no small factor in placing the Exposition out of debt more than three months before closing time, and this without a dollar of Government aid. And so, those who were chiefly responsible for this remarkable accomplishment were duly presented with plaques at a public gathering called together for this purpose on September 24. Messrs. H. D. H. Connick, director of works; Arthur H. Markwart, assistant director of works; Guy L. Bayley, chief mechanical and electrical engineer; E. E. Carpenter, chief civil engineer; Shirley Baker, construction engineer; William Waters, superintendent of construction; W. M. Johnson, engineer of fire protection; and L. F. Leurey, assistant chief mechanical and electrical engineer were those to whom this recognition was accorded, and we add our own meed of appreciation to those who have shed fresh lustre upon the engineering profession.

PUTTING the United States Reclamation Service on a business basis was suggested by Mr. Myron T. Herrick in an address before the International Irrigation Congress. While everyone recognizes both the ability and honesty of the engineers of the Service, and the magnitude of their achievements, it must be admitted that settlement on the projects has been disappointingly slow. Much of the land has fallen into the hands of speculators, and many of the *bona fide* settlers are seriously hampered by being unable to finance improvements on their property. It is doubtful whether the Government will get its money back on many of the projects. Although the need for irrigation was so little appreciated when the Reclamation Act was first passed that the method adopted for financing the work was probably the only one that could have received the approval of Congress, the Nation is not necessarily bound to continue in force business methods that have proved to be unsatisfactory. Mr. Herrick proposes that each project stand upon its own feet. Fifty to seventy-five year bonds are

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to be issued by the Federal government covering not only the cost of the original works, but also providing a fund from which loans can be made to actual settlers for the improvement of their property. These bonds would be a first lien upon the land, and, being backed by the National credit, could be floated at a low rate of interest. At present, while the settler pays no interest on the cost of the reclamation works, a high rate is charged for any money borrowed for improvements. Under the proposed method, the total interest burden upon a whole project might be actually less than at present, while the settler would have the advantage of a much longer time in which to pay off his loan. The control of the funds of the project would gradually pass to the local water-users' association, which would be organized on lines similar to the German *Landschaften*. There are many details to be worked out, and the application of the plan to the existing projects presents a number of difficulties, but Mr. Herrick's general scheme seems to be the most feasible yet proposed for putting the reclamation projects on their financial feet.

The Contractor as a Human Being

So far as we know, the Society for the Prevention of Cruelty to Contractors has never been organized, but every little while something happens to indicate that it should be. Last month, we commented on the report that the Board of Supervisors of Tulare county, California, had awarded a bridge-contract on a bid that was palpably too low. We are glad to be able to report that the Board finally decided to reject this bid and award the work to another contractor whose bid will probably allow him at least a living wage for his effort. A similar case arose recently in Stanislaus county, however, in which the supervisors took the opposite course. A firm of reputable contractors submitted the low bid for the construction of several small bridges. They later found that an error had been made in their computations, and that their total bid was considerably under the lowest possible cost for which the work could be done. Accordingly, the contractors appeared before the Board when the bids were opened and asked permission to withdraw their tender. This permission was refused, on the ground that the entire matter, so far as the Board was concerned, was purely a matter of 'business.' This, however, is not 'business' as we understand it, and we protest against taking anything from a man without rendering a fair equivalent therefor. The Board doubtless assumed that, even if the fear of financial loss tempted the contractors to do inferior work, the engineer in charge could prevent its acceptance. Assuming that the work is well done, the contractors must suffer loss. Such losses may even be so great as to bring about financial embarrassment before the work is completed. There will then be legal delays, another letting of the contract, and other troubles too numerous to mention. It is more than likely that when all incidental expenses are added to the cost of completing a half-finished job, the total actual cost will be greater than if the work had been let at a fair price in the first place. The few dollars saved by mulcting the contractors, should not endear the county officials to their constituents. All sound business is a matter of equitable 'give-and-take,' and contractors are entitled to fair treatment from those for whom they are doing work. The decision of the Board is no inducement for contractors to bid on county-work in Stanislaus county. It pays to be fair—even to a contractor.

Publicity and the Engineering Profession

The American Association of Engineers has been formed recently at Chicago. Mr. W. D. Wilcox is president and Mr. F. H. Newell is one of the more prominent members. The object of the Association is stated to be "the advancement of the general welfare of the engineers of North America, as distinguished from the more purely technical functions performed by the existing engineering societies." The objects most emphasized are the improvement of the conditions of employment of engineers and the influencing of legislation pertaining to engineering subjects. The principal means for accomplishing these ends, as well as an end in itself, is to be the diffusion of information among the general public regarding engineers and their work. National and local engineering societies have been invited to co-operate with the new organization.

In these days of multiplicity of societies of all kinds, the promoters of any new association must show a good reason for its existence, but it is a fact that many of the purposes of this association are at best but inadequately served by any of the existing societies. Until the public becomes as much accustomed to looking to engineers for advice on engineering matters, as it now is to looking to lawyers for advice on legal matters, just so long will engineers have to wait before they assume their proper position in the world at large. This cannot be accomplished by publishing papers on such subjects as 'The Value of n for Tuberculated Cast-Iron Pipe,' in the transactions of one of the national societies. Nor, we are free to admit, will the publication of articles in technical periodicals be of much help in accomplishing this object. The general public sees neither one class of publication nor the other. In plain words, the engineering profession needs a press-agent. It is unnecessary to give examples of the absolute ignorance of the simplest engineering facts that is shown, not only in the daily press, but also in the most reputable magazines. Yet we know that it is possible to write popular yet technically correct articles on engineering subjects that the layman will read and, at the same time, excite neither the anger nor the mirth of the engineer. There are eminent engineers who are not only able to handle both men and machinery, but can wield a pen as well. It would seem that the new association might consider the popularization of the engineering profession and its work through the medium of magazines and periodicals. There is more need for a bridge across the gap between the engineer and those who should employ his services than for any more concrete structure.

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REVIEW OF THE MONTH

CONSIDER the delegate to the International Engineering Congress; he attends no technical sessions, neither does he participate in the discussions, but Solomon in all his glory never bedecked himself with so many badges. The generalissimo of a Central American army would turn pale with envy at the resplendent gorgeousness of them all. Everybody had at least two badges, that of his own engineering society and that of the Congress itself. Those who were members of more than one engineering society were in a fair way to become permanently round-shouldered at the excess of hardware stowed abaft the beam. Members less favored with society affiliations and suffering temporary eclipse through their paucity of decorations, had themselves registered as guests at all of the society headquarters. Thus they were as completely badged as possible, those who would be referred to as "perfect forty-eights" in cloak-and-suit parlance wearing their dignities with becoming grace, while others of the light and lissome variety had to compromise for their lack of beam by stringing their badges on in double rows. The Tower of Jewels hung its head in shame when the various bodies of engineers in turn were duly plaqued by the high-hatted masters of ceremonies in the Court of the Universe.

IT was a great two weeks, great for everybody, San Francisco, the Exposition, the local engineers, and their confreres who came from afar on the excuse of an engineering congress in order to see the Exposition. The total registration was something over one-thousand, or approximately one-third of the total membership of the Congress. About 750 attended the opening address on Monday, September 20, principally to avail themselves of the privilege of seeing and hearing Major General Goethals. He is not an orator, great engineers seldom are. He is a doer rather than a talker; nevertheless in listening to his address, full of modesty as to himself, giving full credit and appreciation for the work done both by his predecessors and associates, the personality of the man shone out in bold relief. To an analyst of impressions, one could see in him not merely the military autocrat, but the diplomat and the broad, capable executive that he has proved himself to be, ruling all sorts of men, of all kinds of temperamental and racial peculiarities, and getting a most surprising best out of all of them. If the Engineering Congress had done nothing else but permit the engineers of the country to see and hear General Goethals, this privilege alone was worth a long and expensive trip across the continent, and more.

AS far as the technical sessions were concerned, the result was the same as that attending practically all Congresses and similar gatherings. The papers were in many cases quite long, and at some of the section meetings at least, they were read in full by the authors. Of those who attended the meetings, the majority had not read the papers which were up for discussion. It is not surprising, therefore, that little was forthcoming in the way of discussion that was worth while. There is but one way that we know of to obtain good discussion on any technical subject, and that is to insure preparation beforehand by those who are expected to participate in the discussion. The chairman of the meeting should select those who in his opinion are best fitted to discuss the subject in question, and by furnishing them with advance copies of the papers, ample time for preparation is assured. This course, we understand, is to be followed, now that the Congress is over, so that excellent discussion by those fully qualified will be bound in with the copies of the transactions before they are delivered to members.

IT seems hardly reasonable to expect boys on a holiday to select the school-house as a scene for their jollification. The charms of the Exposition proved a potent lure, when the only competition was the prospect of listening to hard, dry papers, difficult to digest, especially when the warm September sun and blue skies of California were beckoning on the outside. The barker on the Joy Zone voiced the call of the wild, and one by one attendance dribbled until, during the last few days, only a corporal's guard of the very faithful put in an appearance. This is not intended as a criticism of the Congress. It is merely the written expression of the manifestation of perfectly human attributes on the part of many learned gentlemen, who were out for a holiday, and proposed to have it.

AND then the banquets, oh, those banquets! And the receptions, dances, lawn parties, bay trips, excursions and whatnot! Now that the last guest has been sped upon his way, carrying with him the remains of a digestive power-plant that has been operating at 200% overload continuously for two weeks, we can see visions of dietary reform in many households for months to come, while the mere thought of a menu commencing with hors d'oeuvres and ending with some unspellable liqueur induces a nervous collapse. In the words of Harry Lauder, "First we dined; and then after we dined, we wined; and then after we wined, everybody seemed to have something to say." And they did.

"LADIES and gentlemen, we have with us this evening," and so on. The toastmaster, in a most unaccustomed but conventional boiled shirt shot the opening gun. Then the non-speech-making banqueteers set-

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tled back in their chairs and learned for the first time that the United States is the greatest of nations, that California is the greatest among states, that San Francisco is a pearl among cities, and that the engineer is the niftiest little two-fisted citizen in captivity. Applause, loud and continuous! And we enjoy it all, every one of us. Man is a gregarious animal and loves to rub elbows with those of his kind, but the engineers as a class are, if anything, too diffident and prone to hold themselves aloof from general gatherings. This is a mistake that such organizations as the Engineering Congress and the various engineers' clubs are trying to correct. Like the man of large family who sought for all his progeny a family ticket to enter the side-show tent to see the giraffe, it is just as important that the engineer see and know the layman, as that the layman should see and know the engineer.

IN this thought lies the nub of the whole thing. It is the social feature of such gatherings as the International Engineering Congress that is productive of the most good to the engineer and the profession as a whole. The renewal of old friendships and the creation of new, the genuine delight of social intercourse among congenial spirits, the interchange of ideas in an informal way, all of these are the real thing, even though it be partly obscured by the thin veil of the ostensible motive for the whole performance. Thus are the rough edges taken off the individual and a broader spirit of co-operation fostered that is of lasting benefit to all. Here, then, is to all who have worked so hard and unselfishly to make this, the greatest gathering of engineers ever held, a great and lasting success. Here is to Professor W. F. Durand and Mr. W. A. Cattell, to whom more than any other individuals that we know of, is due the lasting gratitude of the engineering profession in the accomplishment of a monumental task, under particularly trying circumstances, in such a way as to leave no room for doubt that no task, however difficult, is too much for the engineer.

BUT there were other engineering gatherings besides the International Congress and the conventions of the four National societies. Two National and two Pacific Coast associations of road-engineers and others united in the Pan-American Road Congress. While it was unfortunate that so many of those on the program not only failed to appear, but did not even submit papers to be read before the convention, nevertheless a number of interesting addresses were delivered, and the discussions brought out many points that will doubtless prove useful to the delegates. The importance of placing a road properly at the start was emphasized, since this is a feature that is hard to alter, while surfacing and even foundations may be changed with comparative ease. The employment of convicts on road-work was discussed at considerable length, the general sentiment being in favor of the wider use of this class of labor. The speakers who discussed road-financing were generally in favor of raising funds for permanent highways by means of bond issues. It is to be regretted that road-maintenance and the general subject of unimproved roads received so little attention.

THE delegate to the International Irrigation Congress was able to attend its sessions and gratify his appetite for sightseeing at the same time, for meetings were held successively in four different cities, commencing at Stockton, and proceeding to San Francisco by way of Fresno and Sacramento. Probably the most significant thing about the meetings was the recognition of the importance of the human element in the success of an irrigation project. Given sufficient funds, it is a comparatively simple thing to store flood-waters and convey them to the land. To give the farmer on the land a fair chance for success is a far more difficult matter. On most irrigation projects, both public and private, all comers are treated alike, no attempt being made to select the men who, by training or otherwise, are fitted to make a success at the difficult calling of irrigation-farming. Again, few men who are so fitted and can be induced to settle on a new project, are able to finance themselves at the start without outside help. The problem of providing this help so as to do the most good is one that the proposed Rural Credits Board must meet.

DEHYDRATING the stock of the People's Water Company of Oakland, California, has reached another stage with the filing of a foreclosure suit by the banks named as trustees for the various bond-issues. That the squeezing process will extend to the bonds as well as the stock of the company seems inevitable, for there is now outstanding $20,000,000 in stock, and $19,500,000 in bonds of various issues, while the Railroad Commission was able to find only $14,000,000 in actual assets. It is possible that the Commission was unduly conservative in its findings, but it seems certain that the bond-holders must submit to some shrinkage in values.

SPENDING money before you even know where it is coming from, is a time-honored pastime. The Pan-American Road Congress was disturbed by a dispute between the Pacific Coast and the Middle West delegates as to whether or not the Federal government should expend $25,000,000 in the construction of a military highway along the Pacific Coast from Vancouver to Tia Juana. Peace was finally restored by the passage of a resolution recommending that the Government investigate the feasibility of such a project. 'Preparedness' has, for the time being, backed 'efficiency' off the boards as a catchword, and the country will be fortunate if many blunders, and perhaps some crimes, are not committed in its name. When Congress convenes in December there will be enough schemes proposed to swallow up the entire national wealth, and many of them with even less merit than a Pacific Coast military highway, which would be excellent, if we could afford it. Incidentally, it might be pointed out that military highways are often just as convenient to the troops of the enemy as to those of the country itself.

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Electro-Chemical and Electro-Metallurgical Possibilities of the Pacific Coast

By J. W. BECKMAN*

Available Power. Nearly half of the potential water-power of the United States is to be found in the comparatively narrow strip of land bounded on the east by the Rocky and Sierra Nevada mountains, on the west by the Pacific Ocean, on the north by Canada, and on the south by Mexico. The United States Government gives the minimum potential water-power of the entire country as 26,736,000 hp. Of this, 11,504,000 hp. can be developed in the States of Washington, Oregon, and California, divided as follows:

Washington	4,932,000
Oregon	3,148,000
California	3,424,000

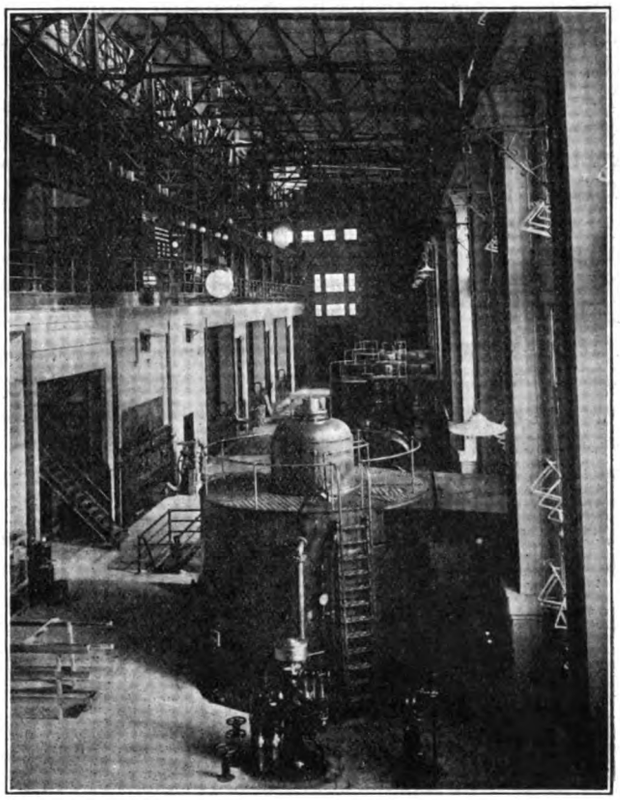
Figures compiled by W. E. Herring of the Puget Sound Traction, Light & Power Co. show that only a small proportion of the available power is developed. The distribution of developed power is as follows:

	Developed hp.	Percentage of possible power.
Washington	306,000	6
Oregon	105,000	3
California	430,000	8

Alaska belongs to the west coast of the United States. The potential water-power of Alaska has never been estimated, but conditions in the southeastern part of the territory especially are such that this region is likely to rival Norway as a producer of cheap and abundant water-power. So far only a small fraction of the available power has been developed.

Cost of Electric Energy. The erroneous opinion has prevailed that the cost of electric energy on the Pacific Coast is so high as to be prohibitive for electro-chemical industries. As a matter of fact energy can be obtained close to the generating stations as cheap as, if not cheaper than, at Niagara Falls. Of course, the power at the end of a long transmission-line is considerably higher priced than close to the generating station. Even under such conditions large reductions in price are made to industries that can operate on so-called 'off-peak power.' The size of these reductions depends on the consumption and may amount to 40% of the prevailing price. The Great Western Power Co., which operates the largest power-house on the Pacific Coast, is able to furnish power, if sufficiently large blocks are desired, at such prices that even fixation of atmospheric nitrogen, if carefully conducted, would be a financial success.

The power-house and power-sites of this company, from which close to 600,000 hp. can be developed, are all within easy reach of tide-water. It may be stated in passing, that Niagara Falls is four times as far from tide-water as the above mentioned power-sites. The importance of the power produced by the Great Western company is enhanced by the fact that it is not only near tide-water, but is also surrounded by various raw materials essential to electro-chemical and electro-metallurgical operations. For these reasons this power is probably destined to play a leading part in the electro-chemical development of the Pacific Coast. When one also considers that one-fifth of the population of the Pacific Coast resides in the vicinity of San Francisco bay, it is evident that the immediate electro-chemical development of this part of the United States is largely dependent upon the Great Western company, which supplies much of this district with energy.



INTERIOR POWER-HOUSE AT BIG BEND, CALIFORNIA.

There are also a number of projects that will be able to furnish power that can compete with the proverbially cheap power of Norway. Such power can be obtained in Alaska at the well-known project on Speel river, ideally situated on tide-water. Another project

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is situated at The Dalles, Oregon, on the Columbia river, near the newly-opened canal, which makes the whole of the Columbia river navigable. All through this part of the United States there is still a great deal of potential water-power, the development of which is not yet even projected. Many sites are so situated that the development of the projects would be expensive. If developed at the present time, financial failure would result on account of remote situation, scarcity of population, and lack of electro-chemical enterprise.

While the War continues in Europe it will be difficult to form an opinion as to future labor-conditions on the Pacific Coast. Whether the opening of the Panama Canal will have any marked influence on the labor market is uncertain. At present the laboring class is composed almost entirely of either native-born Americans, or else naturalized Europeans, who have lost touch to a great extent with their native country. Besides these there are the Chinese, Japanese, and Hindus, who are mainly engaged in agriculture and logging. It is well known that they are not met with a 'welcome,' justly or unjustly. By means of international 'gentlemen's agreements,' and by exclusion, the influx of this type of labor has been limited to a great extent, if not eliminated. Therefore, the laborer that is to be considered at present, is really the best type of European; the man who is familiar with both the language and the ways of the land; the man who is wide awake among his own countrymen, and has been able to shake off the shackles of the congested foreign quarters of the large Eastern cities; the man who has forgotten the squalor of the mining towns of Pennsylvania and taken his destiny away from the padrone into his own hands.

From these considerations, it is evident that industries operating on the Pacific Coast get the pick of the Eastern labor-market. For a long time in the future much the same condition will prevail, since European laborers are conservative and go only to centres already established by their own countrymen. From these centres, their distribution over the surrounding country is slow. Until a large population of directly imported European labor has collected in Parific Coast centres, on account of industrial advantages, there will be no direct movement of any magnitude of European labor to the Pacific Coast.

Wages do not differ materially on the Pacific Coast from those prevailing in Chicago. An extensive investigation has been made of prevailing labor prices and the following figures have been compiled:

Unskilled labor, $1.50 to $3.00 per day.

Skilled labor, $3.00 to $5.00 per day.

The average working day is eight hours.

The climate of the Pacific Coast should not be overlooked in considering labor conditions and labor costs. In consideration of modern researches made regarding the effect of climate on efficiency, it is well to remember that the equitable climate of the Pacific Coast, with mild winters and cool summers, is stimulating, and that the average output of a man is materially greater during the year than in the East. Labor-unions and the closed shop are strongly established in some districts of the coastal States, while in others the open shop prevails.

Refractory Materials. During the past few months much has been said about California magnesite, and too much cannot be said about it, since it is extremely refractory, being practically pure magnesium carbonate. With suitable admixture it should furnish an ideal material for furnace-linings. There are large deposits of this mineral in California, and so far they have not been worked extensively. Asbestos deposits of the short as well as the long fibred varieties are to be found in large quantities in California and other places on the Pacific Coast. There are large kieselguhr deposits. These are of such a character that solid blocks can be cut, and used in furnaces and other structures.

Fire-clay of high quality is produced and excellent fire-brick is manufactured. The brick has given better results in open-hearth operations here than the best standard fire-brick made in the East. Large deposits of dolomite of good quality are found at various points. A large quantity of pure quartz is available in rock formation, as well as quartz-sand. Most of the materials mentioned above occur at widely distributed points on the Pacific Coast, most of them being in easy reach of transportation.

Reducing Materials. At present the Pacific Coast is not favored like the East, with high-grade anthracite coal. Alaska is as yet only a potential producer of coal, but it promises to supply the West Coast in the near future with high-grade anthracite, low in ash and sulphur. Alaska, British Columbia, and the State of Washington are all producers of soft coal. At various places on the coast, lignite may be found. At present neither the soft coals nor the lignites are of importance as reducing materials. China, Japan, and Australia, all supply the coast with coal, some of which is high-grade anthracite of a quality and price low enough to compete advantageously with coal brought in from the East.

In many of the densely wooded districts of the Pacific Coast, there is an abundance of timber that would only be improved if a part of the stand was cut carefully and burned to charcoal. Southeastern Alaska especially, is covered with overgrown timber, ideal for charcoal-burning. It may be obtained at low prices. Charcoal produced from this timber would provide a pure and comparatively cheap carbonaceous material for reducing purposes.

The oilfields of the southern part of California, produce much natural gas as well as oil. This gas is an ideal reducing material for metallurgical purposes. Much of the oil itself is practically free from sulphur and possesses all the essential requirements for reducing metals from their ores. The present-day technique has not as yet evolved a method by which the two latter reducing-agents can be used with success in electro-

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metallurgical processes, but since the essentials necessary for reduction are present in natural gas and oil, to make such processes operative is merely a matter of the solution of thermal and mechanical details.

As coke is obtained as a by-product in the manufacture of illuminating gas from soft coal, so a fine lampblack is produced in gas-plants operating with crude oil. The lampblack formed is nearly pure carbon, with a small amount of heavy oil mixed with it. A considerable quantity of this material is produced every day at the various gas-houses along the Coast, and forms an ideal reducing-material, since it contains no ash and no sulphur. At present this material is a by-product, and, in many cases, offers a problem as to its most advantageous disposal. On account of its physical condition and its purity it is an ideal raw material for the manufacture of carbon electrodes for which there already is a demand on the Coast. This demand is certain to increase rapidly.

Fluxing Materials. Large and conveniently situated deposits of limestone of a high degree of purity are to be found at many points on the Pacific Coast, offering an ample, cheap, and certain supply of this important mineral. With the cheap fuel available, burnt lime can be produced at a profit for about $3 per ton.

Salts. There are large deposits of various salts especially in the deserts and arid regions of Southern California. Sodium sulphate, sodium carbonate, sodium chloride, and sodium nitrates, are all found in varying quantities. Sodium chloride is also produced at small expense along the beaches. The salt-water is evaporated in shallow basins by the sun and wind, and deposits are formed of nearly pure salt, which is suitable for industrial or domestic purposes. The salt can be produced and stacked ready for transportation for about $1.50 per ton. What promises to be of interest not only to the electro-chemical industries, but also the world at large, is the occurrence of considerable quantities of potassium chloride in the southern part of California. These deposits are being developed and will shortly be a source of potash for many purposes. The increasing demand for boron and its compounds can be filled from large borax deposits.

Metalliferous Raw Materials. That the Pacific Coast has some unusual iron ore deposits, both as to size and quality, is not generally realized. Some of the ore is of such a quality that it could compete with the best Swedish ores. There is no reason why the Pacific Coast, with abundant supply of high-grade iron ores, with quantities of cheap oil and charcoal, and with hydro-electric energy obtainable in large quantities at low prices, should not be an important iron-producing region.

An extensive steel industry can be established since ores are available that are suitable for the manufacture of alloys such as ferro-manganese, ferro-chrome, ferro-vanadium, ferro-silicon, ferro-tungsten, ferro-molybdenum and similar alloys. There are large and easily accessible deposits of both barium sulphate and barium carbonate, also bauxite, the latter being suitable for the manufacture of aluminum. There are also deposits of cassiterite, or tin ore.

In making mention of these various metals, the intention is to show the multitude of possibilities open to the electro-chemist and electro-metallurgist. Although many of these metals are at present obtained from ores found on the Pacific Coast, by means of more or less expensive processes, there still remain possibilities of utilizing new forces and new agents, both economically and efficiently, in place of the present methods.

Possible Industries. From the foregoing it is apparent that there are a great number of industrial possibilities. There are a few, however, that are perhaps more apparent than others. The industry that shows the greatest promise at the present time for early development is the manufacture of caustic soda and bleaching-powder. This industry and its possibilities have been thoroughly investigated, and it is certain that a medium-sized caustic-soda plant could be operated not only successfully, but profitably on the Pacific Coast.

Potassium-chlorate manufacture is another industry which should have special possibilities here, as necessary raw materials are produced on this Coast.

There is a demand for calcium carbide in South America and also in the mining districts of the western part of the United States. The raw materials are obtainable here and the manufacture of carbide should be a flourishing industry on the Coast.

Nitrogen-fixation industries seek cheap power, and cheap and abundant power is available here as well as a large market for the product. The soil of the coastal region is being rapidly depleted of nitrogen. In some sections the soil is physically well adapted for farming purposes, but lacks nitrogen altogether.

The iron industry, as has been indicated before, has great possibilities on the Coast. The present electric shaft-furnace plant has not been a complete success in this country. There is, however, every reason to believe that success would be attained if use was made of past experience as well as present practice in Sweden, particularly if new processes were applied, using oil, or oil and charcoal as reducing agents.

The Pacific Coast should logically be the world's distributing point for cyanide used in gold extraction. With suitable raw materials, with electric power available, and with the market close at hand, such an industry should flourish.

Aluminum manufacture, lead reduction, zinc production, and the electrolytic refining of copper are other electro-chemical industries which should be developed to some extent. Practically all of the blister copper produced here is shipped East for final refinement, although conditions are perhaps less favorable in the East for this process than on the Pacific Coast where the metal is produced.

There is a large demand for high-grade steel castings, produced by means of the electric furnace, and although there are now three small furnaces operating

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on the Coast, there is place for a number of others.

Markets. Sweden and Norway are looked upon as the world's electro-chemical countries. Cheap water-power has been given as one of the reasons for this position, but if Sweden and Norway had as many opportunities for large, cheap, power-installations as there are on the Pacific Coast, these countries would dominate the world's market for electro-chemical products. Their electro-chemical industries would be total failures, even if the processes were working to a nicety, if they had no market for the products. The total population of these two countries amounts to 10,000,000 people, mainly engaged in agriculture, thus furnishing only limited market possibilities. The industries are successful in spite of limited home-markets, because they have looked beyond the boundaries of their countries and entered the world markets, thus finding outlet for their products.

Electro-chemical manufacturers on this Coast must be inspired with the same desire as those in Sweden and Norway, since the population of the Pacific States is about 5,000,000 people. More than half the world's population lives in lands bordering the Pacific Ocean, and their markets are waiting to be supplied by industries situated on this Coast. It may justly be said that the greater part of these countries facing the Pacific Coast are inhabited by people that are still living under primitive conditions and whose demands are limited. Such assumptions may be partly correct today, but experience shows that as these countries get more and more in touch with the well-organized nations of the world, their needs for the products of these nations increase correspondingly.

This fact is strikingly illustrated by statistics from the Philippine Islands, showing the imports both before and after the American occupation of the Islands as follows:

Year.	Imports.	Year.	Imports.
1890	$16,277,305	1903	32,971,882
1891	16,804,783	1904	33,220,761
1892	16,310,137	1905	30,876,350
1893	15,893,094	1906	25,799,266
1894	14,245,005	1907	28,785,855
1895	13,052,442	1908	30,918,357
1896	Not given	1909	27,792,397
1897	" "	1910	37,067,630
1898	" "	1911	49,833,722
1899	13,113,010	1912	54,549,980
1900	26,601,436	1913	56,327,583
1901	30,279,406	1914	56,011,570
1902	32,141,842		

The above figures are on the authority of the War Department, Bureau of Insular Affairs, and show that the imports have more than quadrupled during the fifteen years the Philippine Islands have been under United States control, while they were practically stationary during the years prior to American occupation. The increase is significant, as indicating the growth of imports as a country becomes accustomed to more regulated conditions. Many of the South American and Far Eastern markets are now open, giving unprecedented commercial opportunities for industries situated on the Pacific Coast.

Financial Conditions. There was a time in the history of the Pacific Coast when gold-mines and oil-wells were the only undertakings which interested men with capital. Fortunes were made and lost over night. This neurotic condition is being outgrown. Men with money are still eager to add to their wealth, but wild, sky-high flights in the financial world have lost their interest.

It is natural for the West to look to the East for capital, but it is equally natural for the West to look for capital within its own boundaries. It is impossible for the Pacific Coast to be financially emancipated from the East. However, the time is not far distant when it will walk side by side with New York and other Eastern money centres, prepared to give, as well as to receive, assistance in the realm of finance.

Conclusion. The Pacific Coast is still practically an untried country from the electro-chemist's point of view. Much cheap, undeveloped power is still to be found. Developed power is available at prices as low as anywhere in the East. The natural resources of the coastal districts are unlimited. They abound in minerals suitable for refractories and for fluxing. Charcoal, oil, natural gas, and lampblack from gas-houses, as well as high-grade anthracite, suitable for reducing purposes, are all obtainable on the Pacific Coast. There is a great abundance of various kinds of salts and metalliferous ores in many parts of the Pacific Coast, affording unusual opportunities for electro-chemical and electro-metallurgical industries.

Conditions on the Pacific Coast are now ripe for various electro-chemical and electro-metallurgical undertakings. The manufacture of caustic soda is especially adapted to this section; low cost of salt, low cost of fuel, cheap power, and a large market for the caustic as well as for the bleach, assure immediate success to such an undertaking. The labor obtainable is the best, and is not higher in price than in Eastern centres. The climate is ideal. The financial conditions on the Pacific Coast are sound. Blue-sky laws protect the investor against wild-cat schemes. Any electro-chemical or electro-metallurgical industry operating on the Coast would have to look to other than the local markets for the sale of its products. With more than half of the world's population facing the Pacific Coast, an industry here has greater commercial possibilities and opportunities than one in Sweden or Norway where there are large, near-by, fully-developed markets, but where there is also keen competition.

Except for a few small industries, electro-chemistry would be known here only by name. The Pacific Coast has as yet neither financial strength, nor experience enough to develop these industries alone. The possibilities are here; the Pacific Coast is quickly waking up to this fact, but it is still forced to look to the East for an electro-chemical stimulus.

Will the East come forward and give it?

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Human Engineering

By CHARLES R. TOWSON*

The more one sees of the practical problems of industrial plants, the more clearly he sees that modern industry is paying a penalty for the neglect of the most important factor, the human. The reason for this neglect is not easily stated, but a partial explanation is found in the lack of recognition of this factor in much of the philosophy of industry and in the training of industrial leaders. Consider Tredgold's definition of the engineer: "One who directs the great forces of nature for the use and convenience of man." This is a classic; what better definition has been given? And yet it illustrates the omission for which industry is paying the penalty, for it contains no suggestion of the fact that one of the greatest forces the engineer directs is human nature. Yet this human factor is woven into the whole fabric of engineering. E. A. Ross, of the University of Wisconsin, has shown that there is a gap in the technical education of the engineer, and says "It is unthinkable that this gap, the omission of the study of the human side of engineering, shall be much longer tolerated." Little wonder that the human factor in industry has been neglected, when the professional conception has given it small place and the technical curriculum practically none at all.

If professionally trained employers have neglected the science of humanics, how much more excusable is the failure of other employers to develop human efficiency with something of the same scientific skill that has produced our machine efficiency. But it is becoming recognized that nothing that concerns the welfare of the worker, either in or out of working hours, is negligible with the wise employer of today. Todd, of the University of Pittsburgh, has said, "Because of the complexity and solidarity of modern social life, no profession or trade can ignore the social background of its activities, and this is especially true of the engineering profession." Modern engineering is acknowledging this fact in a remarkable way in the reports of some of the major engineering achievements. Much space is given to describing, not only methods of securing and handling workers, but also to dealing with their working, living, and leisure conditions; to the things that affect not only the physical welfare, but the social and moral as well.

The story recently told by Goethals, "How I built the Canal," may not be typical of the modern engineers' report of the achievements of himself and his associates, but it is striking in the prominence given to the human forces and to the details of plans for the comfort and contentment of the workers. His narrative ranges all

TYPICAL ASSOCIATION BUILDINGS IN CONSTRUCTION CAMPS.

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the way from health measures and accident prevention to the methods of satisfying the wife of employee Jones that her quarters were on a parity with the quarters that employee Browne's wife boasted, thus preventing a social upheaval, which might have had as bad a result as the slide in the Culebra cut.

Gowin, of the University of New York, says "the value of understanding the human equation is something that our more alert managers are realizing as never before. And better yet, they are making headway rapidly. It means better relations in industry, better wages to labor, and increased dividends to capital."

It is not meant that employers should exercise paternal care over the workers. American ideals will not allow this to become a permanent method. But a knowledge on the part of an employer concerning the forces that affect the workers and a right use of these forces, whether home, school, church, or state, is not only desirable, but essential to that employer's greatest success. It is in this connection that the work of the modern industrial type of Young Men's Christian Association is receiving attention by employers. It is being used in the larger industrial centres and by the largest industries as well as by companies employing not more than a hundred men. Single large companies or a group of industries in the great manufacturing cities have secretaries giving full time to their plants. Isolated industries, such as the small cotton mill villages, coal-mining and metal-mining communities, and logging and construction camps, are furnishing buildings and financial and moral support with satisfying results in apparently every case. *Coal Age*, in a recent issue, states: "Much has been accomplished in the betterment of conditions in mining communities by the Young Men's Christian Association, and the establishment of a branch of this organization in every mining camp would be of the greatest value to the coal-mining industry." Similar endorsement is given from the iron and steel industry by such companies as the United Steel Corporation, the International Harvester Company, and the Westinghouse Air Brake Company, as well as by textile manufacturers from Massachusetts to Alabama. The same testimony also comes from coal and copper mines, saw-mill town, and logging camps.

Some have feared that an agency having a religious motive could not serve men of differing creeds and no creed; but for thirty years the growing success of the Railroad Young Men's Christian Association has been an answer to this question. Men of every faith are in its membership. There are more Roman Catholics in this Association than members of any other single denomination, and in some places more than all the others combined. The work appeals everywhere, because it gets hold of men in a way that no mere club ever does, in its effect on character. Also it enlists men in working together for their own improvement.

The strength of this agency as an ally of industry is largely in its trained secretaries, who represent both employees and employers on a mutual and unselfish basis. More than four hundred such secretaries are at work in railroad and industrial fields and are receiving direct financial support from the companies. It may be noted, however, that for every dollar contributed by employers for the maintenance of Young Men's Christian Association work the employee gives another dollar, thus making it really a mutual enterprise.

A conspicuous service being rendered by this Association is seen in the construction camps of the West. Contracts have been completed sooner, relations have been pleasanter, men have been more loyal and contented, and many more dollars have gone back home to families because drunkenness, gambling, and vice have had such a competitor in the far-off camps. It has substituted constructive influences for the destructive forces usually found in those camps. A study of the details of its activities will show that its program fits the all-round man, physically, mentally, and morally, and that it is a social force affecting the life of the whole community. No finer substitute for the saloon has been found. John Hays Hammond, engineer and publicist, says: "The experience of employers of labor where the Young Men's Christian Association exists has completely demonstrated the great economic value of the Association to the local industries. By the influence and example of the employees who are members of the Association, a great stimulus is introduced into the entire body of employees for the elevation of those standards of living which are indispensable factors in industrial success. Its trained secretaries are a real asset in any industrial community."

CONSTRUCTION OF COLUMBIA RIVER HIGHWAY AT MITCHELL POINT, OREGON.

By G. ED. ROSS*

One of the most picturesque places on the Columbia highway is situated a few miles from Hood River at a place locally known as Mitchell Point. The road here is about 185 feet above sea-level, and overlooks both the Columbia river and the Oregon-Washington Railroad & Navigation Company's track.

After two careful preliminary surveys in the winter of 1914, this route, although expensive to construct, was selected in preference to one over the hill. The cost of $\frac{3}{4}$ mile of highway will be approximately $50,000. The work includes a tunnel 390 ft. long, 18 by 19 ft. in cross-section, with five windows overlooking the river, each 18 by 19 ft., and a concrete viaduct 200 ft. long connecting the west approach of the tunnel with the other side of a rock cliff.

The active construction of this part of the highway was started April, 1915, and will be entirely completed by the end of August. The tunnel and viaduct is being constructed by Standifer-Clarkson Company, of Portland, Oregon. Multnomah county is spending $1,250,000 on paving as far as the Hood River county line. From this point there is a well constructed highway as far as Mitchell Point and the celebrated Hood River valley.

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Maintenance of Irrigation Systems

By FREDERICK HAYNES NEWELL*

The maintenance of an irrigation system presents problems quite distinct from those connected with its operation or even with the original building of the works. Maintenance is essential to proper operation. It is also closely allied to construction. In many cases it is a prolongation of the latter, and there is difficulty in drawing a sharp line between what may be called the original work and that added later during the gradual evolution of parts. Some structures built as a necessary part of maintenance, were contemplated from the beginning, though not finished at the time of the original work. For example, in the case of the enlargement and repair of a headgate, certain portions were completed as part of the first construction, foundations or spaces were then left for additions such as might be needed in the course of systematic development of the irrigated project. Later these additional parts were inserted as part of the maintenance of the system, although in another sense they were the completion of the original plans.

In considering maintenance and in classifying expenditures it is necessary to draw a somewhat arbitrary line between what may be called (a) the primary construction and (b) the secondary additions, the latter being essential to the growth and development of the irrigated lands. The same difficulty is encountered in attempting to make a fair division between the expenditures for operation and for maintenance. Although the purposes are in themselves entirely distinct, yet the work may be classified sometimes under one head or under the other, especially as it frequently happens that for economy the same body of men may be engaged at one moment on the work of operating and at another time on that of maintenance.

Definitions: The items of the expenditure included under the head of maintenance of an irrigation system, are those growing out of the keeping of the works in good condition, as distinguished from those expenditures of time or money which have to do with delivering water to the land. The cost of cleaning the canals and repairing structures is properly chargeable to maintenance, while the cost of turning the water on and off and of keeping the record of the time and the quantity delivered is properly chargeable to operation.

The same man or gang may be employed both on operation and on maintenance, that is to say, a canal rider whose business it is primarily to see to it that the water is turned into the laterals and the farms may spend part of his time in removing weeds or other obstructions or in making temporary repairs. Under a careful system of cost-keeping a certain proportion of his time may thus be charged to maintenance. Most maintenance work, however, is done immediately before or after the irrigation season and when the water is out of the canal, so that it is often relatively easy to distinguish between operation and maintenance by considering the time of year in which the given expenditure is incurred.

The amount of time and money which can be spent on maintenance is more largely governed by the judgment of the manager than is the operating expense, because of the fact that neglect of the maintenance is not as immediately noticeable as failure properly to operate the works. If they are not operated systematically and effectively, there is immediate complaint, but the maintenance may be neglected for possibly a year or more without immediate or serious consequences. The only way to ascertain whether the maintenance is effective, is by frequent inspection or by taking account of stock, as it would be termed in other mercantile operations, to determine whether the works in hand have increased or decreased in value.

It is this difficulty of ascertaining whether the maintenance is effective or not which has led to much misapprehension as to the true cost of maintenance. The careful manager will expend considerable sums of money in keeping the canals clean and the structures in excellent condition, and will be prepared to meet any emergency. The result, however, is not always apparent, because with a smoothly working system, there are no comments expected, as it is to be supposed that the manager would keep the system in good order.

On the other hand, the manager who is desirous of making a record for economy may reduce the expenditures for maintenance, and allow the canals and distributing system gradually to fill with silt or the structures to become weak. If in time of unexpected flood, or cloudburst, some accident occurs, it is then attributed to natural causes, rather than to neglect of the details of maintenance. It is only by careful study of the situation by competent and impartial men that it is possible to ascertain from year to year whether the maintenance is thorough as is necessary for effective results. In other words, the condition of the entire system must be known at short intervals in order to ascertain whether it is possible safely to reduce expenditures for maintenance and whether there has been true economy or merely the withholding of necessary work until an accident occurs.

Betterments. Closely connected with maintenance is a class of expenditures which is likely at all times to

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give rise to much discussion; namely, those items of outlay which tend not merely to maintain the irrigation system in its original condition, but gradually to improve it. For example, when the system is first built under pioneer conditions it is usually most economical to build many structures of wood, as at that time there are many unknown conditions of development, and freight rates on cement and iron are usually high. Later on, when the wooden structures decay, they may be replaced either with similar wooden ones, in which case the cost is charged to maintenance, or else with more permanent steel or iron structures, in which case the excess cost over the wooden replacement may be charged to betterments.

In the same way, the canal system as originally built may be constructed of minimum capacity, with the idea of ultimately enlarging it as the demands for water increase. It is frequently not economical to build a canal full size at first because for several years it is not called upon to carry a full supply of water, and with reduced velocity due to small demands, the canal tends to be rapidly filled with sediment, whereas, if built of small size it can be more easily kept clean. If such a canal when being cleaned is increased in capacity the cost of the cleaning to the original size may be considered as maintenance and the added expenditure to bring about increased capacity may be charged to betterments.

The distinction between these two classifications can usually be made only at the time when the results of the work are fresh in mind, and when it is possible to make a careful apportionment of items of expenditure for labor and materials. It is quite important that some such distinction be made in order that the owners or management of the canal may know how much has been paid out for ordinary maintenance, comparable with that of other systems, as distinguished from the gradual improvement of the property.

Repairs to Canals and Laterals. The repairs to an ordinary canal in earth consist largely in replacing portions of bank that have become eroded or of removing the sediment resulting from such erosion. The problem of maintenance is similar, on a small scale, to that of bank protection of rivers. Under natural conditions the current of most rivers swings from side to side, cutting the bank on one side and carrying the eroded material for a short distance, dropping it to form bars; then, gaining force, the water attacks the opposite bank. If the point of attack can be adequately protected so that the water cannot remove any considerable amount of earth, it is evident that there will be little to be deposited at lower points along the stream.

The same conditions prevail in an artificial channel, although to a lesser degree if the slope and consequent velocity have been correctly determined in advance of construction. With increased demand for water such velocities are apt to occur at one place or another that the banks are attacked. If the material is particularly soft, erosion takes place unless protection is afforded by the growth of willows or similar plants or an artificial shield is made by placing at the point of erosion, sagebrush or branches of cottonwood, willow or other bushes, holding these down with stones or wires.

The repairs to earthen channels thus consist mainly in replacing and rendering relatively permanent those points subject to attack and in removing the sand or silt that may have accumulated at lower points as a result of erosion. These repairs may be made during the field season or, if relatively small in importance, they may be left until water is out of the canal and the places that need attention are more readily accessible.

Cleaning. Cleaning canals and laterals may be distinguished from repairs as being usually necessary because of the fact that the velocity of the water at various points is less than that needed to keep the muddy water from depositing its load. Theoretically, a canal and distributing system should be so planned that any muddy water received at the head is carried along with a certain velocity until it is delivered to the fields of the farmers. As a matter of fact, however, it is rarely possible to maintain this velocity and at various gates or checks the water becomes still, and more or less sediment is deposited.

In the case of canals taking water from rivers which during high floods carry excess amounts of sediment in suspension, it is impossible to have a velocity sufficient to keep this sediment from being deposited. Canals from the Rio Grande or Colorado rivers furnish an example of this condition. The fall of the country is not sufficient to enable canals to be built on a grade steep enough to maintain such a velocity in times of low water as to prevent sediment being deposited. If such a grade were possible, excessive erosion would result. It is necessary, therefore, to provide, as far as practicable, certain sand-traps or sluices to take the sediment from the water near the head of the canal and then to clean out the entire system systematically once or twice a year, or even oftener as the mud accumulates.

Employing Farmers. In small privately-owned systems, the individual landowners combine to do this cleaning or else divide it up among themselves, each man being responsible for a certain portion of the system. In larger canals, efforts have been made in a similar way to have the farmers living under the canal do this cleaning by contract. As a rule, however, this has not been wholly successful, because it is frequently necessary to have cleaning done at the time when the farmer should be occupied at home. It is also extremely difficult to make a contract that will be enforceable against the individual who does this cleaning incompletely or poorly, as the cost of inspecting and measuring up the work to prove lack of thoroughness is a considerable proportion of the cost of proper cleaning. When, therefore, the individual interest of the farmer is not sufficiently great to lead him to do a thorough

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piece of work, it is usually impossible to let contracts to the farmers with any considerable degree of success.

Managers of projects should make efforts, however, to furnish employment, as far as practicable in cleaning and maintenance work, to the farmers or residents within the area covered by the project. Although experience has shown, as above stated, that it is usually difficult to secure the labor of farmers in critical times when repairs are needed, yet a better spirit is engendered if it is understood that preference will be given to farmers in such employment. It is essential, however, to have a small gang of men regularly hired, and, as necessity arises, to increase their numbers by employing the farmers by the day.

It has been asserted by some canal managers that in this heavy, manual work of cleaning ditches, the labor of the farmer is not always as efficient as that of the ordinary day-laborer. The farmer is not accustomed to work in gangs or consecutively at such heavy work. It has been pointed out in the publications of the Department of Agriculture that, although farm work is usually hard, and the hours are considered long, yet as a matter of observation, it appears that the average farmer does not put in eight full hours of effective work, and that the majority are not accustomed to a daily routine of sustained physical effort such as is required in cleaning canals. In the old days of pioneering, all of this work, as well as that of building the irrigation-works, was performed by the farmers themselves, but it is generally recognized that these men, driven by necessity and selected by their ability to endure hardships, were above the present average, at least as far as physical strength is concerned.

On the newer projects, where a miscellaneous population has gathered from all parts of the world, there are apt to be many disappointments to the manager in securing labor for such work as cleaning. The men who are competent are usually too busy on their own farms, and the others who are in evidence at the corner grocery, or who have apparently little to do, cannot readily be induced to take up the necessary work, although their families need the wages. Thus it is not unusual for it to be necessary to bring in labor from outside to perform in an efficient and economical manner, the work which should be carried on by residents of the community.

As illustrating some of the difficulties of the canal manager, in one instance in Nevada, it was necessary to make some repairs during the winter. The settlers were offered the opportunity at good wages, but none responded. The work was ten miles or more from their homes and one excuse or another was given. One man had a team which he said must be fed. He could not be induced to put his team on the work, but spent his entire winter taking care of them at home. Another man's entire possessions seemed to consist of a small shack and 30 hens, and he excused himself from working during the winter because he had to stay at home to feed his hens!

In the same way that it is necessary to have a small body of laborers to be depended upon in emergencies, it is often necessary to own and maintain enough horses to have at all times a small outfit to insure that the most needed work is performed. This expense may appear doubtful at first, because of the fact that the horses are needed perhaps only three months out of the year, but these are the months when the farmers cannot spare their teams.

Contract Cleaning. Whenever conditions appear to be such that good results can be obtained by making contracts for cleaning out a canal at a fixed rate or unit price, there may be economy in so doing. Such contracts may be made with farmers living in the vicinity on the basis of so much per mile, payment to be made after inspection of the work and acceptance as being in full accord with the specifications.

A small bond for faithful performance of the work should be required, and a time limit set for completion, with forfeiture of so much per day for failure to complete. Without such bond and forfeiture, the average man is apt to put off the work and finally seek to excuse himself if the weather is not propitious or other conditions turn out to be not as favorable as he anticipated.

Repairs of Structure. As distinguished from the relatively simple although laborious details of cleaning canals and repairing earthwork, the maintenance of structures requires the employment of a certain degree of engineering and mechanical skill. Many of the earlier and smaller structures on most distributing systems were built of wood in order to save expense, as at the time of building transportation facilities were not perfected; also for some years after initiating the work the structures are not needed of full size. Thus it is frequently a matter of economy to build them smaller than will ultimately be needed, with the intention of renewing or enlarging them when the irrigated lands are more largely utilized, as by that time the wood will probably have become decayed. The replacement of the wooden structures by concrete and steel may be carried on systematically as part of the necessary repairs and the extra cost of enlargement and of substitution of more permanent material may be considered as betterment of the system.

At the time of renewal many questions which were in doubt at the time of the original building of the works have become more nearly settled, such, for example, as the amount of water required for the land and the consequent capacity of the structures. When first planned it may have been necessary to assume a certain duty of water but after use for about five or ten years, some of the lands may have become saturated to a point where far less water is needed than was at first anticipated, and it is found that it will be unnecessary to build the structures as large as originally assumed. On the other hand, it may be found desirable to extend certain portions of the system to take

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in other lands and then the structures must be increased in size. In short, the repairs which must be made from time to time are based upon a revision of the early plans and a better knowledge of the conditions to be met.

Protection of Sandy Banks. One of the largest items of expense in some of the main-line canals are those arising from the sandy nature of the soil and the ease with which it is eroded. The wind on the surface of a broad canal creates waves of considerable size, and on long stretches exposed to the sweep of the wind, the wave action is serious. Constant vigilance is required in watching for wave-cutting, especially on the outer bank of the canal and temporary protection must be afforded by sand bags and more permanently by brush and stone.

One of the problems of the manager is to procure suitable material at reasonable expense for protecting these sandy banks. Stone is usually absent from the neighborhood and the cost of importing it is prohibitive. Willow or cottonwood branches or large pieces of sagebrush are usually the most available materials. The branches are laid where the waves are cutting the sand with the butts placed downstream, and the mat thus formed is held in place preferably by barbed wire fastened to stakes driven into the bank.

Slides. Wherever a canal is built in earth along a hillside a change in natural conditions is necessarily introduced and time is required to bring about a relatively stable adjustment. The original slope has been the result of centuries of carving by the wind and rain and of adjustment of load. It may be on the verge of unstable equilibrium just ready to slip or slide, lying at what is sometimes called the angle of repose. The throwing of an additional load of earth on one side or another may bring about such a disturbance as to start the earth sliding either gradually or rapidly. Even during construction a settlement along the hillside may be noticed.

The greatest factor in disturbing natural conditions is that of the introduction of water, which, saturating the earth, not only shifts and increases the weight on the hill-slopes, but, in a way, lubricates the earth and facilitates the slipping or sliding of one layer upon another. The slides may be into the canal from the steep slopes above, or more generally away from the canal, the lower saturated bank sinking and permitting the water in the canal to escape.

The slides from above into an irrigation canal are similar in many ways to those on a large scale on the Panama Canal, and arise from the same varieties of causes. Usually they are the result of removing the support from the lower side of the slope and of weakening the adhesion of the upper layers of the slope by the introduction of water, which softens the supporting material. There are certain fine clays that receive and transmit water slowly and which, when thoroughly wet, will flow even on gentle declivities. A canal cutting through these clay beds and bringing water to their lower edges will almost invariably be obstructed in time by sloughing of the clay beds, which will not cease moving until the upper slope is perhaps as flat as one foot vertical to twenty horizontal. Beds of sand and gravel or of surface debris gradually work downward into the canal, due to the lack of cohesion of the particles, the movement continuing until the surface assumes a slope of one foot vertical to four or five horizontal.

The injury and resulting expense from the sliding of material into a canal is relatively small compared to those where the lower bank tends to slip outward. In the first case, the flow of water can be maintained by frequent removal of the material that falls in, but in the latter case the whole system is jeopardized, and the water in the canal, which is needed for the irrigation of hundreds or thousands of acres of land, is diverted to the destruction of lands and homes.

Where the lower banks are unstable and show signs of slipping, it is necessary to take every possible precaution and to maintain daily, if not hourly, watch for any signs of weakness, especially during the first few months or seasons after the canal has been put into use. It is assumed that in the construction of the lower banks great care has been taken to avoid slides by keeping the canal prism well in the natural ground and by compacting the material to be deposited upon the lower bank. Usually the chief danger, however, lies in the fact that the original undisturbed soil may have been in a condition where it was pervious to water and nearly ready to slip. Under such conditions the additional weight of the excavated material deposited on the lower bank and the softening of the lower layers by percolating water renders the whole area unstable. It is only by carefully admitting water to the canal and watching conditions that it is possible to determine whether additional work must be undertaken to prevent slides or whether by careful handling the banks will gradually settle into a permanent, safe condition.

The prevention of slides usually calls into play all of the ingenuity and experience of the irrigation manager. A method adapted to one kind of ground may not be advisable in another. Usually the first step is to attempt to drain the lower part of the slope where conditions appear to be bad and if possible to put a blanket of gravel or similar pervious material on the lower toe to hold it down, and to counteract the tendency to slide by offering a support to the soil that is pressing down toward the bottom.

Sometimes a thin puddle-lining of the canal may be advisable in connection with the protection of the lower part of the slope so as to obstruct the percolation of water into the bank. At the same time drains are provided for carrying away as much as possible of the percolating water. In other words, the lower bank should be kept as nearly dry as possible, as in this condition it will slip less readily than when wet.

The driving of piles or the buttressing of the lower part of steep slopes has been attempted in places, but

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with relatively small success on account of the difficulty of finding good supporting ground for the piles, or, if this is found, it often happens that the weight of the moving material is so great as to displace any ordinary line of piles or other supports. Sometimes, as a last resort, it may be found necessary to put the canal in a tight flume along the points where the lower banks are sliding and thus carry it over these treacherous spots.

Vegetation on Canal Banks. The best protection for canal banks is that afforded through the growth of vegetation, grasses, weeds, bushes, and small trees, such as cottonwood or willow whose roots hold the soil in place. Some of this vegetation serves a useful purpose in this way while other varieties are highly injurious by tending to clog the canal and prevent the free flow of water or by dropping seeds into the water, these being carried out on the fields of the farmers and thus spreading noxious weeds.

The irrigation managers should study the character of vegetation which occurs naturally along the canal banks and if necessary introduce plants or sow seeds of such useful plants as may take root under the prevailing conditions. Various experiments must usually be undertaken to determine the relative cost and value of different grasses for use in this connection. Before undertaking these experiments, results of similar work elsewhere should be considered. The sowing of barley, rye, and similar cereals has been tried on various canals and the cost of planting and cutting these has been compared with the similar cost of cutting and burning ordinary weeds.

By careful observation of the vegetation which occurs naturally and by comparison of costs of various methods of cutting or controlling the weeds it is usually possible to arrive at conclusions for each locality as to the best method of treatment. There is as yet no one definite method adapted to the varying conditions of large and small canals and the different climatic conditions, nor is it always possible to draw a sharp line between the useful and injurious weeds which occur along a canal, as some of these weeds most valuable in holding the earth under certain conditions become highly destructive under others.

Wherever suitable enclosures can be provided such that sheep, goats, or cattle can graze on the banks of the canal, they are sometimes quite effective in keeping down weeds. This is the case particularly with sheep, and experiments have been made of close herding, notably in the Salt River valley of Arizona. When they are lean and hungry, the sheep are effective; but it is reported that after a while, with excess of feed, the sheep are apt to neglect their duty and eat only the more succulent weeds. There is no doubt, however, that under certain conditions sheep can be used to advantage.

Combating Pests. There is a never ending warfare between the irrigation manager, aided by his assistants, and the innumerable animal and plant pests which live along or under the canal system. The newly built banks offer tempting places for work of burrowing animals, and a single gopher or muskrat may dig a hole in a few hours affording an outlet to the waters of a canal, which enlarged during the night, will sweep away thousands of yards of earth. The trapping and poisoning of these animals must be carried on continuously until the banks have become consolidated through months or years of settlement. Even then vigilance should not be relaxed, but the canal riders should be always on the watch for any disturbance of the earth by burrowing animals. Each canal rider should be provided with suitable traps and from time to time put out poisoned grain or bait in localities where indications of these burrowing animals are noted or where they are even suspected to exist, protecting this poisoned grain carefully, of course, from being found by domestic animals or human beings.

The weed pests afford even more continuous occupation. Especially in the south they spread with great rapidity along the canals. In the case of moss growing in the canal or of large weeds on the side, the growth in a few weeks may be such as to materially reduce the flow of water.

In many canals carrying clear water the growth of aquatic vegetation, especially the so-called moss, is a serious matter. It is necessary to incur considerable expense in keeping this clear, and in some localities extraordinary difficulties have been encountered, necessitating the shutting off of the canal and permitting the ground to dry out, even at the risk of loss of crops in the meantime.

In the case of the Bear River canal, in Utah, it is stated that moss has been practically eradicated in three years by using a disc-harrow stripped of seat and double-trees. The tongue is cut to four feet in length. To this are hitched two ropes, one leading to a team on each bank. By adjusting the length of these ropes, the harrow can be run on even slope or in the bottom. It is claimed that this digs up the roots and that they float down with the moss and are removed. Originally these canals were foul, and the first year it was necessary to go over them three times in this way. The second year, two cleanings were needed, and now they require cleaning only once each year. Little moss is left, and it is believed that this method may operate successfully in other localities. It is certainly cheaper than attempting to mow the moss, nor does it interrupt the flow of water in the canal.

Other devices have been tried for getting rid of moss, for example, dragging heavy chains or similar weights along the bottom of the canal, the chains catching and dislodging the moss, or pulling up the weeds by the roots. There are also various mowing machines which have been adapted to this work, some of which are fairly successful. It may be noted in this connection that the moss grows best in clear water, and that if the water is muddy for any considerable length of time, the moss does not flourish.

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Proposed Highway System for Ventura County, California*

On August 24, the citizens of Ventura county voted, by a large majority, for a bond issue of $1,000,000 for the construction of a system of county highways. Exclusive of the forty or fifty miles of State highway, now constructed or under construction, there are about 500 miles of roads in the county. Of these, 104 miles of the main trunk-highways are to be improved under this bond issue. The proposed system is shown on the accompanying map. Two types of pavement are to be used: bituminous macadam similar to that used in the construction of the Los Angeles County highway system, described in WESTERN ENGINEERING, for September 1915, and concrete base with bituminous wearing surface of the type used in the construction of a large part of the California State highway system. The estimated cost of the work is as follows:

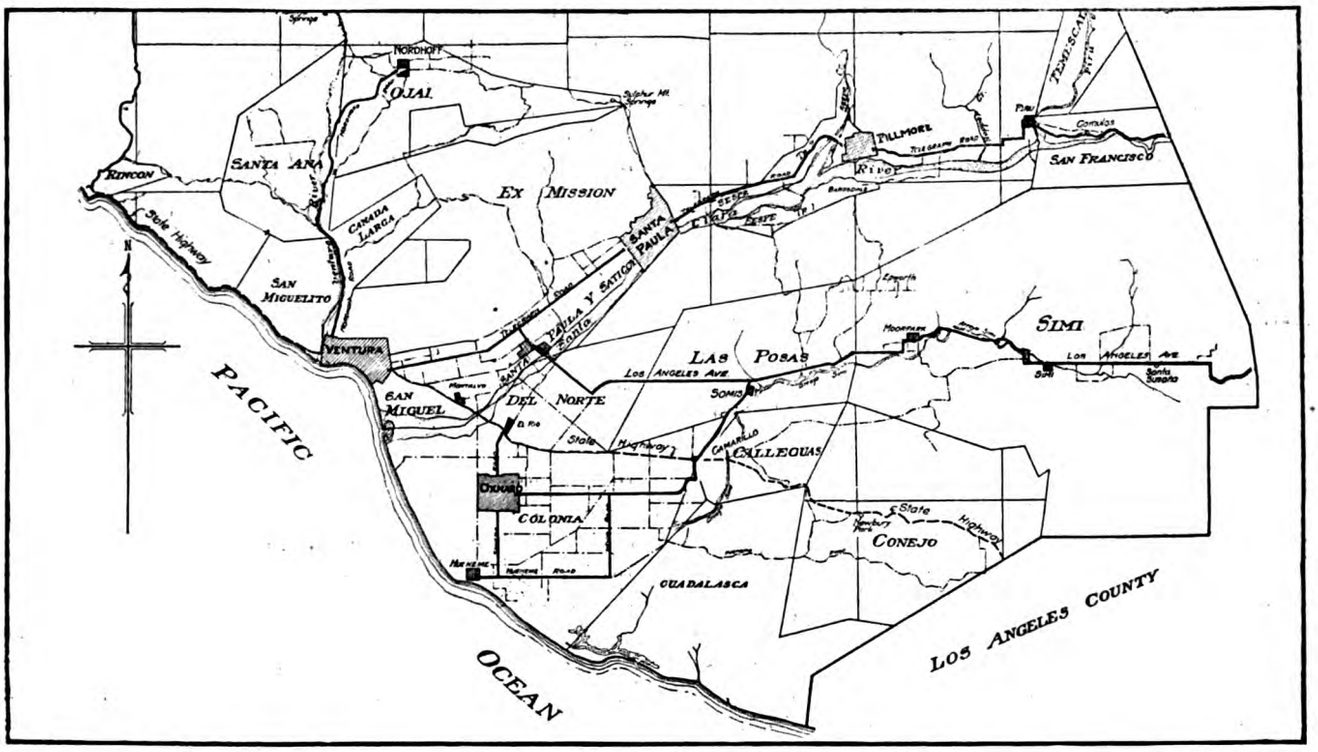
Bridges and culverts	$ 170,000
Excavation and shaping of roadbed	204,000
Guard-fences	9,000
Protection jetties	5,000
Pavement	563,000
Engineering and inspection	49,000
Total	$1,000,000

In addition the board of supervisors will construct connecting links through the incorporated towns on all the proposed highways. This work will be done from the general county funds as rapidly as the money becomes available.

The construction of the system is to be under the supervision of the county highway commission, composed of A. C. Hardison, chairman, H. H. Eastwood, and William McGuire. Charles W. Petit, county surveyor, has been appointed chief engineer for the commission. The headquarters of the commission will be at Ventura.

The commission intends to erect a rock-crushing and a gravel-screening plant and to furnish materials for the work, but will have the actual construction done by contract. Some of the bridge-work will be started immediately. It is expected that plans will be sufficiently advanced to permit the awarding of the first contracts for paving during January 1916, and that the entire system can be constructed in two years.

At the end of five years, the redemption of the bonds is to commence, and is to continue at the rate of $40,000 per year until at the end of 30 years the entire issue is retired. It is estimated that the greatest addition to the tax-rate on account of the bonds will be 29c. per $100 of assessed valuation, and that the average during the life of the bonds will be less than 20c. per $100. This is without making any allowance for decreased cost of maintenance on all the permanently-constructed roads.



MAP OF PROPOSED SYSTEM.

*From data furnished by Charles W. Petit, engineer for the Ventura County Highway Commission.

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The Valuation of Oil-Lands and Properties*

By M. E. LOMBARDI†

The title of this paper is 'The Valuation of Oil-Lands and Properties' and I have taken oil-lands to mean undeveloped oil-bearing lands, and oil-properties to mean such lands when wholly or partially developed. The valuation of undeveloped lands, indicated geologically to be oil-bearing, means the hypothecating of a developed property, based on the geologist's report of the oil prospects of the land in question and on the history of adjacent properties. Therefore, the methods of valuation are the same in principle as for oil-properties, only there is less data on which to base conclusions.

In a study of any type of properties there are several elements which must be investigated closely. They are:

The element of future price of oil,
The element of future production,
The element of future cost of development,
The element of future cost of production,
The element of geology,
The element of chance,

and various other factors which are local in their character.

The owner of a partly developed oil-property has, in determining the value of his holdings, the following problem: He has as his stock in trade a certain amount of recoverable oil in the ground, how much he does not know. He can sell this oil in the future for so much per barrel, how much he does not know. It will cost him so much per barrel to install facilities, namely, wells for recovering this oil, how much he does not know, although he can approximate this cost. It will cost him so much per barrel to produce this oil, how much, he can, again, only approximate. The only basis for price-fixing seems to be the settled production of existing wells, and this is probably why the so-called 'Pennsylvania method' of valuing oil-properties came into use early in the history of the industry.

Pennsylvania Method. As applied by some of the largest buyers of oil-land, this method is as follows: An oil-property is priced on the basis of a certain amount per barrel of daily settled production from wells on the property. This price varies with the price of oil, and is usually about $100 a barrel per day for each 10c. variation in the price of oil. The price for the property must be such that money will be returned in, at most, four years. Undrilled land must be sufficient to hold production for these four years, taking account of the inevitable decline of the old wells. Wells must be six months old before their production is considered settled.

I will briefly compare the methods used in two of the largest valuations made in this State. This will illustrate, perhaps, the tendencies of the past ten years. The first of these was made in 1901 in the Kern River field, and the second is now being made of properties in several of the San Joaquin Valley fields. The valuation of 1901 was for the purpose of consolidating a great number of individual holdings and was made by a committee of three able engineers. The purpose for which the valuation was made necessitated comparative figures only, which robs the report of much interest.

At that time there were only 470 producing wells in the Kern River field, but the boundaries of the field were fairly well defined. A quarter-section near the centre of the field was taken as an example of the best oil land. Its value per acre was assumed at so many thousand dollars, and the committee was instructed to express the value of all other properties in terms of this one. The engineers found that the value of land could be shown by a series of roughly concentric circles about the approximate centre of the field. The points on which emphasis was laid in placing these circles were, briefly, as follows: A careful measurement was taken for about 30 days of actual production of all wells, always taking into account, and allowing for, fortuitous circumstances which might be present in any particular case; account was taken of the age of the well and the nature of its perforations; the fact of its sanding up; whether or not the wells had penetrated all the oil-bearing measures; and whether the water had been properly shut off. No money value was given to wells, but only to land. No money value was given to differences in gravity of oil, the range being only about 4° or 5° Baumé, but value was attached to light gravity as a factor in cheap recovery and handling.

In fixing values, weight was given to depth of sands beneath the surface, drilling difficulties, thickness, productiveness of oil-measures, distance to lower water-level, etc. Average thickness of sands was obtained by numerous cross-sections. Productivity of sands was determined, aside from records of production, by taking samples of sand and measuring the possible oil-saturation and the residual proportion remaining after all free-flowing oil had been removed. This record was considered to give an approximation to the total quantity of possible extractable oil in the field. Only one-half of the net oil-sand was considered prolific. This seems to have been the chief factor of safety introduced.

The second valuation which I will outline is now being carried on by a committtee appointed by the Independent Producers' Agency in California and involves some 150 companies.

*Abstract of paper presented before the International Engineering Congress, San Francisco, September 1915.

†Flood Bdg., San Francisco, California.

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The Pennsylvania method was considered and rejected as being inapplicable because of lack of data at the present time for fixing any barrel-per-day value to California production. In other words, the production is not considered settled enough for this method, which was reserved as a check. The Saturation method was considered and rejected, first, because of the great known variation in the saturation of sands; second, because this method takes no account of increased production-costs, per barrel produced, as the flush production declines.

The method adopted is based upon the assumption that the production from wells already drilled on any property will decrease according to a constant decreasing ratio, this ratio having been established by the decrease of production in the past. A production-curve is deduced from these data. A curve-value is applied for the initial production of new wells to be drilled and decreased according to the typical curve. To each yearly production of the old wells is added that of the new wells drilled, thus obtaining the total future production of the property. From the curve the probable yearly production for each year of the assumed life of the property in question is computed. The total yearly expenditures are then computed independently, regardless of production, since these expenditures are considered somewhat of a constant. Any additional plant or cost of development is charged to the year when this expenditure is assumed to be made. Total expenditures are then subtracted from gross receipts and net receipts are thus obtained at varying prices of oil. Present value of net future-receipts are calculated on an interest basis compatible with the chance involved. Ten years is taken as a basis for redemption fund. In valuing surface equipment, only that equipment is considered which can be given a salvage value and removed from the property without interfering with its present operation, such as drilling-tools, warehouse supplies, livestock, etc. Other surface equipment is considered in the calculations of future expenditures, and its bearing on the valuation is indirectly considered through these expenditure calculations.

For use in future cases it is interesting to note that the curves of decline of production constructed by the Producers' committee for the Coalinga, Sunset and Midway fields are strikingly similar, so much so, that if the Coalinga curve were used for the lower fields, the probable error would have been negligible, considering the uncertainty of the other factors entering into the problem. The Coalinga field is about 90 miles from the Midway field and they are not in the same geological horizon.

Price. A study of the yearly average price of crude oil for the past ten years, taken from 'Production of Petroleum in 1913,' by David T. Day, shows an average variation for the past ten years, in the principal United States fields of 56% of the highest average yearly prices.

That prices will probably not show this range in the next ten years may reasonably be inferred from the fact that facilities for oil-transportation have increased and will increase still further. This includes not only the joining of different fields with tide-water by pipelines, but also the construction of the Panama Canal and the increased fleets of tank steamers.

It is fairly safe to assume that world-wide distribution and consumption will more than keep pace with probable increase of production during the next ten years. Therefore for the valuation of any particular property, the local factors having an influence on price are those which the engineer must particularly study. These are the quality of the oil; future local markets and, in the case of fuel oil, its competition with other fuels; the chance of large and sudden increase in production, locally; the possibility of Government control of prices.

In California, the price of oil is fixed by the base price for fuel-oil. Oils suitable for refining are sold at an increased price for higher gravities. There is a small market for strictly road-oil at varying prices. The true value of an oil, however, can only be determined by chemical analysis, since gravity is not a sure measure of its refinable content. It is a question whether or not the producer will ever be paid for the true value to refiners of his oil. Nevertheless, in the valuation of a property, a chemical analysis should be made for obvious reasons.

The history of oil shows that oil from new fields, being of a somewhat new chemical composition, has usually been under-valued for refining. The advance in refining technology has largely obviated this. Moreover, oil is now more valuable for different refined products than formerly. Gasoline-content is now desired whereas kerosene-content used to be most important; and fuel-oil is growing in importance.

Perhaps the most potent factor, and the hardest to determine, in price variation is a sudden increase in local production. This has knocked the bottom out of oil prices in Oklahoma within the past year. During the past five years, it has repeatedly depressed prices in California.

There is no doubt that Government control of prices, either direct or indirect, is a possibility of the near future. The chances are that legislation will have a great deal more to do with the oil business in the future than it has in the past ten years. Its effect on price, if any, in fields threatened with overproduction will probably be of advantage to the producer.

Future Production. A study of future production depends on: (1) past and present production of neighboring wells, and, (2) geological investigations, including thickness and saturation of sands. In California, dependence is beginning to be put more on past history of production than on present settled daily production. This is, probably, because of the recognized instability of production of most of our fields, both from unforeseeable causes and from 'sanding up,' etc. California experience, covering a large number of

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wells in the two largest fields, indicates that at any one time from 5% to 8% of the wells are temporarily non-producing. A study of the past history of production and the careful attempt to apply data thus gained to a prognostication of future production is perhaps the most interesting feature of the valuation of their various properties recently undertaken by the Independent Producers of California.

With the permission of their Valuation Committee, I will describe the method adopted. In each separate unit of territory of the same general characteristics, a campaign was first undertaken for collecting all possible production-data, both from properties to be valued and from neighbors. For each well or group of wells was determined: (1) Date of completion; (2) initial settled production; (3) average production for each year of life; (4) all other facts bearing on production, such as appearance of water, etc. From these records, by groups, curves were drawn representing the average decline of wells.

A general curve for the territory was then constructed. Fig. 1 shows the form this curve assumed for

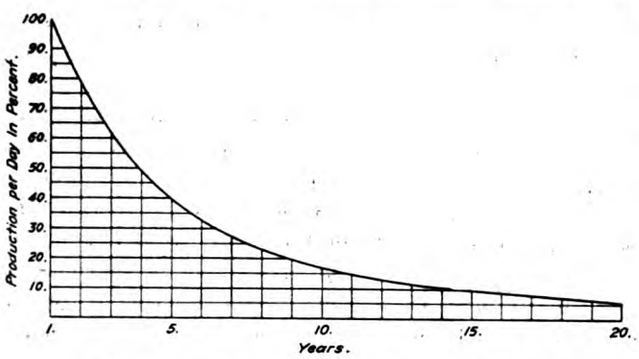

FIG. 1. CURVE OF DECLINE OF PRODUCTION.

half of one of the largest California fields, where geological conditions are very uniform.

The available data extended over only seven years, but it was assumed that the average life of the field would be far longer than that. In order to extend the curve, a study was made of the history of the largest and oldest group of wells available and an equation worked out for their known decline. This equation was used in extending the curve, with a modification after the thirteenth year.

This curve was applied to properties in the same districts whose records did not give sufficient data for individual curves, or whose land was insufficiently drilled or too recently drilled to provide records for study, it being only necessary to know the average daily production for the first year. The curve for any property gave the total probable recoveries for wells then drilled. It remained to estimate recoveries for all future wells.

It is evident that a well drilled near a group of old wells will not have as great an initial production as it would have had if drilled in the same position when the territory was new. Also, the longer the old wells have been producing and draining the territory, the less will be the initial production of the new well.

In determining the initial production of the wells to be drilled in the future, the following plan is under consideration: The total recoverable oil per acre is calculated by the production curve for those wells already drilled, which are assumed to drain a certain number of acres per well. This total extraction is reduced to an acre-foot basis. The wells to be drilled in the future are then assumed to produce along the same production curve, the assumed or known thickness of sand beneath them being taken into account. In this manner their total production is arrived at and their initial production obtained from the typical curve.

In studying past production, data from groups of wells drilled at approximately the same time is most valuable, since the factor of new production being continually brought in is a disturbing element in the study of total production returns of a property. It makes no difference if these groups are made up from a single property or from wells across property lines.

If individual gauging tanks are available, two at each well, careful gauging may give good results. Evaporation, escape of entrained gas, and line-losses reduce the production thus determined from 4 to 12%.

One value of individual well-records is the fact that it enables the engineer to study the water-content of the product of each well or group of wells. A well showing an increasing amount of water is to be looked upon with the greatest suspicion. Determination of source of the water and how it can be shut off are matters of management.

In many valuations in the early days in California, the future-production element was studied on the basis of recoverable content of sands, which may be called the method based on geological investigation. The factors are: (1) Thickness of sands; (2) saturation and gas pressure.

The average thickness of sands is almost always known, or may be assumed from logs of neighboring wells, but their saturation and the recoverable proportion of this saturation is almost wholly a matter of guess work. Of course, a uniform sand of rounded grains will hold the most oil. How much can be recovered depends on many factors—gas pressure, gravity, etc. A fair percentage of voids in a well-washed sand is from 30 to 35; the recoverable oil has been variously estimated as from 10% to 50% of the volume of these voids, or from 3% to 17.5% of the volume of the container. As a matter of fact, we have records of production which range from 1% to over 15% of the total volume of the container. In the latter case, a great deal of the shale between the sands was undoubtedly saturated with oil.

It seems that the method based on thickness of sand and saturation is going out of vogue in California. It is valuable as a check, however, and certainly limits the total probable recoveries of the field, if not of a property.

Wherever loose sands form the oil content, a compar-

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ison of production records for individual wells almost invariably shows the great influence that drilling of adjacent wells has on production. Fig. 2 shows produc-

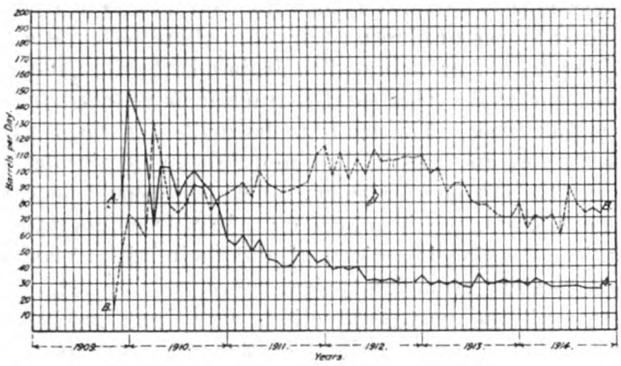

FIG. 2. PRODUCTION CURVES, SHOWING EFFECT OF ADJACENT DRILLING.

tion curves for two wells a quarter of a mile apart. Well 'A' produces from about twice the thickness of sand as well 'B.' They are about the same depth and are finished alike and were drilled about the same time, but there is only one other well within a quarter of a mile of well 'B,' and this neighbor is about 500 ft. distant, whereas there are five wells within 650 ft. of well 'A.' The curves clearly show the superiority of well 'B' as an investment.

Water in an oil-sand, no matter what its source, comes like a thief in the night and will stop or cut down production of any well. This does not mean that the oil is driven out of the sand; it simply means that it is made unavailable, and if the source of the water is found and corrected, the oil will, in nine cases out of ten, come back. The engineer will be justified in looking to the future correction of water-troubles with more confidence than the past would seem to indicate, because of the great advance made in the art of cementing. There is no doubt that there will be a great deal less water let into the oil-sands in the future than in the past, and a great many of the old, incorrectly-drilled wells will be repaired.

Cost of Development. Drilling costs are usually figured on the foot-basis. This varies in California from $3 to $20 per foot, including all charges, depending on the depth of territory, etc. Inaccurate accounting has done much in the past to cloud these records. For instance, interest on money invested in drilling equipment and a correct proportion of overhead has seldom been charged against wells drilled on an operating property. Moreover, expense incurred in 'bringing in' a well and putting it in proper shape for steady production should be charged against drilling.

The cost of maintaining general equipment varies largely with the amount of oil produced rather than with the depth or cost per well. This equipment, including pipe-line, pumps, tanks, gas-separators, and buildings presents few problems peculiar to oil production. In California this cost appears to be about 15 to 20% of the total cost of development.

Cost of Production. First of all, it must be clearly decided what shall constitute production-cost and on what it shall be based. The usual unit is the barrel of oil delivered into the shipping-tanks. A check unit is the cost per well producing. Groups of wells are often taken as a unit, on account of the difficulty of segregating costs to single wells. It is evident that the cost per well is important in the estimation of future costs of production, since, with the decrease in output per well, this will vary far less than the cost per barrel.

Elements entering into the cost of production are now generally taken to be: (1) Field costs, including cost of pumping oil, cost of repairs and renewals of wells, cost of collecting, cleaning, and delivering oil, cost of repairs and renewals of installations and equipments, cost of drilling to maintain production; and (2) general costs, including amortization of investment, general overhead expenses, taxes, and insurance.

The cost of pumping varies with the amount of oil pumped, depth of hole, tendency of wells to sand up, etc. Perhaps within limits, the amount pumped has the least effect on cost per well and the greatest on cost per barrel. Returns from a great many wells indicate that the average well in California produces from 90 to 95% of the time.

The cost of repairs and renewals to wells will be low during the first part of the life of a well. Therefore past records of a comparatively new property are discounted by the valuation engineer. The most costly repairs are those of re-drilling, which are, strictly speaking, renewals. Re-drilling may be necessary on account of a damaged 'oil-string' or on account of water-intrusion. In the first instance, the history of surrounding wells is most important, as the oil-string may 'go bad' at any time during the life of a well, and the shifting character of the sands is the cause. Some oil-producing districts are particularly troubled by collapsing or breaking of the 'oil-string.' Re-drilling on account of water-intrusions is a serious problem, because it involves the life of the 'water-string.' It can be foreseen in some cases, for instance, where an upper water is encountered which corrodes iron or steel pipe. The composition and thickness of the 'water-string' and how it was cemented, if at all, have a direct bearing on its probable life and, therefore, a vital interest for the valuation engineer.

The cost of collecting and delivering oil includes cleaning the oil, gauging it, and mixing it to best advantage where gravity is a consideration in price. These operations all take place on the surface and are problems, which, with the exception, perhaps, of cleaning the oil, present no special difficulties in estimating cost.

The estimates of repairs and renewals of equipment outside of the wells themselves is also a problem which requires ordinary engineering judgment, not peculiar to the oil-industry. The depreciation allowed for this item must, however, be limited ultimately by the life of the oil-measures themselves.

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The calculation of the amount to be spent in drilling new wells to maintain production may be based on the decline-of-production curve already discussed, together with estimated cost of drilling and supporting facilities. It is evident that the greater the number of wells producing, the greater will be this cost; and that the cost will increase with the life of the property, since more and more wells are being drilled. On the other hand, the older a property, the less rapid will be the decline in production from old wells.

General overhead expense, taxes, and insurance are subjects where principles not peculiar to the oil-industry apply. It may be well to point out that the fire-risk is great in the oilfields. It is usually not applied to the wells themselves as apart from derricks, yet many wells are damaged when the derrick burns, by the fall of the tubing to the bottom of the hole.

Development Program. A development program is determined by size and shape of property, known physical properties of sands and of oil, most desirable rate of output, probable future price of oil.

It is complicated by drilling by neighbors along boundary lines and by probability of change in character of sands in different parts of the territory.

A small property surrounded by active neighbors must, of course, be drilled on the lines at a rate at least equal to neighbors' drilling. A neighbor who is loathe to drill, or who is willing to enter into a line-agreement which precludes a drilling-war, is a great asset to a property and should be so recognized. An irregular shaped property is undesirable in direct proportion to the relation of the perimeter to its area, unless the owners or lessees are prepared to wage an aggressive drilling-war. On the other hand, a narrow strip may be valuable, in that one row of wells can draw from both sides and a small acreage can support a large number of wells. In general, a large, compact property allows the most systematic and satisfactory development and also the most economical operation, since distribution of power, collecting systems, etc., may be economically arranged.

It is essential that oil be recovered from a property as cheaply as possible. This means that the minimum number of wells be drilled compatible with thorough development. An effective radius of production must be fixed, that is, it must be determined how far each well will probably draw oil economically. It is obvious that, to win all the recoverable oil, the wells must be close together. This is limited by the yield per well and the cost of development. Many wells simply means speed in recovery at the cost of greater capital invested. Even this may be desirable in some cases.

In all fields, an economic distance between wells is arrived at in time. Observation and experience alone can determine it; but in case the engineer wishes to establish this economic production-radius in a comparatively new field, there are a few lines of inquiry that will help him. In the first place, he can pretty safely assume, in a field where the oil-container is a true sand, that the first boundary-wells will be drilled too close together. That traveling capacity of oil in true sands is great is conclusively proved by the enormous yields of single wells or groups of wells, taking into consideration the thickness of the oil-bearing sands.

It has been pointed out that, theoretically, on account of interest on capital investment, the fastest recovery and abandonment of an oil property is the most desirable. In any new field this would result in a production of oil that would be detrimental to price, and there are other practical circumstances that deter operators from following it out. More often the desirable program is to get a production which will pay first-class interest on the investment and maintain this production as long as possible. The facts that oil travels long distances in time, that production costs are low while gas pressure remains in the field, and that neighbors are drilling up their properties at certain rates, have more or less influence on the program, usually towards the rapid attainment of a large production.

On account of the risk involved, it is generally thought desirable to amortize oil-property in California on a basis of not more than 10 to 15 years, even though the probable life of the field is longer. It seems reasonable to assume, therefore, that at least those parts of the property which are considered fairly established as oil-bearing should be drilled within these years. With a curve for decline of production and for initial production of wells, and a calculated output necessary to pay the required interest on the investment, a theoretical rate for future drilling can be tentatively established. It is influenced by all the questions studied above and also by financial circumstances, and with it are involved nearly all the elements of the problem of valuation. The probable future price of oil is often the deciding factor of a development program. It must be weighed against the loss of interest on capital invested but unproductive, or against a large initial capital expenditure for development.

Financial Considerations. An oil property is typical of that class of enterprise where exhaustion of principal in an assumed period is the controlling factor in financial calculations. It is now recognized that there is no reason why the principles laid down for mines in regard to amortization of capital, depreciation, interest on investment compatible with risks involved, discounting of deferred profits, present value of future ore reserves, etc., should not be applied in general as fundamentals for oil properties.

Amortization of capital is entirely dependent on life of production, as with mines; but in mines this life is more in the hands of the operator than with oil properties. This is occasioned by the fact that oil is not yours until you have it in your tanks. Any oil property is to a certain extent drainable by neighbors. Furthermore, the appearance of water in the sands may render the oil unrecoverable, although the oil, of necessity, must be still there.

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There are two kinds of 'life' on which it is customary to base amortization, namely, life expressed in proportion of oil extracted, and life as expressed in years. The first of these provides for a depreciation charge against every barrel of oil extracted, calculated against the estimated assumed total recoverable oil. This naturally follows in a valuation in which future production is based on volume and extractable content of sands. Its weakness lies in the weakness of this premise and in the fact that it takes no account, unless through an arbitrary factor of safety, of drainage by neighbors, water intrusion, etc. If a property is temporarily shut down for want of a suitable market, while neighbors have satisfactory contracts, the actual depreciation of the property goes on, though not shown on the books by this system. The second 'life,' expressed in years, is based on the estimated life of the whole field and is not applicable to reserve lands not subject to drainage or damaged by water. It naturally follows a calculation of future production based on the decline-of-production curve method. There are strong arguments for both conceptions of 'life.' Of course, they both amount to the same thing in the final analysis, and the question is simply as to which is the safest means of arriving at the desired end. It is therefore advisable to amortize on the basis of a period considerably less that the calculated life of the field, or property.

All capital invested falls in one of two classes: In land, namely, in the oil to be produced, or in development. In some cases, of course, the land may be valuable for other purposes and this value may be considered its salvage value. Money invested in development must, of necessity, be amortized equally with the land.

Depreciation on that part of the principal invested in land is covered by amortization. Depreciation on that part invested in facilities may be considered as that loss in value not made good by renewals and repairs chargeable to ordinary operations, in other words, deferred renewals. It is based on inspection and experience. It is not always necessary for the facilities of an oil-property to be kept up to their efficiency during the entire life of the property.

There are usually three characteristic periods during the life of a property. The first, during which all facilities are new and renewals will be light and production cheap; the second, during which expenses on account of drilling to maintain production and redrilling wells because of collapsed casing, water troubles, etc., will be heavy; the third, after the property is drilled, production is declining, and during which most facilities may be allowed to run down paralleling the decline of production. It would, therefore, seem advisable to accumulate a large depreciation reserve during the first part of the life of the property; in other words, a method should be adopted by which decreasing percentages should be set aside each year for depreciation.

An oil development enterprise calls for:

1. An amortization fund based on a conservative estimated life of the deposits.
2. A depreciation reserve set aside on the basis of decreasing renewals.
3. A surplus fund for meeting expenses for emergency drilling.

Drilling new wells to maintain production, once a satisfactory output is acquired, may be considered, in effect, a charge against operating expense. It seems that this is the simplest view and the safest. Nevertheless, the money expended in these facilities is represented by a value on and in the ground which must be maintained and depreciated, and, in that respect, must be treated as an addition to capital account. This can well be done, however, and yet the cost of maintaining production in calculations of future profits, for valuation, may be distributed as part of the cost per barrel of oil to be produced.

Application of Data to Valuation. It will be noted that all of the elements of valuation discussed above are variable factors, within wide limits. The weight given to each element also varies greatly with the nature of the property under discussion, whether it be deep or shallow, largely drilled or virgin territory, etc. Add to this the great element of chance and at first sight it looks as if a shrewd guess were as good as the most painstaking investigation. Indeed, experienced judgment is perhaps the most valuable factor that can be brought to bear on the valuation question, and until recent years most oil lands were so appraised.

Nevertheless, the results of detailed study are now examined carefully as a basis for the exercise of experienced judgment. Indeed, an equation with two unknown factors may be written, and solved by trial, which will theoretically fix the value of oil properties which are near the beginning of their life. At least, by means of such an equation the weight to be given, in the final judgment, to each of the factors in valuation may be mathematically indicated with the exception, of course, of the factors of geology and chance. For example, we will take an undeveloped property consisting of 300 acres in a partly developed field:

Known or approximated factors:

A. Yield per well, first year = 200 bbl. per day (net saleable).
B. Cost of development per well = $30,000.
C. Price received for oil, net = 50c. per bbl.
D. Cost of production (including drilling to maintain production) = 30c. per bbl.
E. Rate of interest demanded (profit) = 12%.
F. Amortization fund (10 years) = 8%.

Unknown factors:

X = value of land.
Y = number of initial wells to be drilled and charged to capital account to establish satisfactory income; assumed, in this instance, as 15.

Then:—

$$(E+F)\ X+\ (E+F)\ (B\times Y) = A\ (C-D)\times 365\times Y.$$

Substituting:—

$$0.20X+0.20\ (30{,}000\times 15) = 200\times 0.20\times 365\times 15.$$

Solving:—

X = $645,000, or $2150 per acre for the land.

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It will be noted that the most potent factors of this equation are the price received for the oil, the cost of production, and the yield per well. These are also the most variable and uncertain. The yield per well is, though indirectly, involved in net profit, through drilling to maintain production and from operating costs. Of course, everyone recognizes that yield and price are the most important considerations in valuation, and the only value claimed for the above study is that it forms a basis to work on and shows how much variation in any of the factors involved affects the value of the property and in this way gives a starting-point for a more accurate valuation.

Of course, this formula is not applicable in its entirety to any oil property in existence; because such a property would have to be of such a size that, at the proper acreage per well and at the proper rate of drilling to maintain production, it would be just drilled up in ten years. It is offered only in illustration and as a basis for calculation, and as a set of scales on which may be determined, in each particular case, the weight to be given the various elements of a valuation.

Petroleum and Insects

By W. H. SHOCKLEY*

A news item states that the Standard Oil Company is actively prospecting for petroleum in China and that it has lately stopped wells No. 1 and No. 2 at Yen Chang Hsien in Shensi. A private letter from Pekin states that about two hundred Europeans were engaged in the work. One of our engineer friends describes to us his visit to Yen Chang in 1899 and the description gives a vivid idea of an interesting journey.

The start was made from Tai Yuan Fu, the capital of Shansi, and the scene of the massacre of some 35 missionaries in the Boxer troubles of 1900. From Tai Yuan the paths led northwesterly through narrow valleys gay with rose, white, and purple fields of the poppy grown for opium. The gathering of the juice takes place before sunrise. In all 75 miles of poppies was traversed before reaching the Yellow river. The engineer was the bearer of an official proclamation in Chinese, of course, and when posting a copy in a village of five hundred inhabitants, was amazed to find that no one in the village was able to read it. This experience showed that education is by no means as universal among the Chinese as we suppose.

The crossing of the Yellow river was a formidable task and fully bore out the Chinese proverb that innkeepers, carters, boatman, and ya-men runners all ought to be killed; they are all robbers. Perhaps the ya-men runners, who are the hangers-on of the district magistrates, are worst.

Our engineer stopped for the night in a *yao* or cave cut in the loess. The cave was crammed with beds, furniture, and vast earthen jars filled with pickled turnips whose odor makes that of sauerkraut seem a delicate perfume. The jars were too heavy to be moved and the engineer arranged his bed as best he could; voluminous mosquito-netting was tucked under his mattress by his 'Number-One Boy,' and none too soon he fell asleep. Sharp bites brought him to his feet, and after capturing a few bedbugs (*Cimex lectularius*, see Century dictionary), and making sure that his net was carefully closed, he again tried to sleep and was again awakened. Not being able to understand how the bugs could get in, he put a candle on one of the jars and watched. The scene he saw gave him a great respect for the cleverness of the bedbug. The first bug that appeared ran up and down the netting with great rapidity, but missed the opening; after covering much of the surface of the net, it began quartering, exactly like a pointer or setter, making wide horizontal casts; in a few seconds it found the place where the netting overlapped, and pounced on its game. This process was repeated by so many other members of the genus that the engineer was forced to cease his entomological investigations and seek peace in the courtyard, where, to his surprise, he found the whole of his retinue, a dozen men; they, too, had been driven out by the ravenous insects. The party left the unpleasant neighborhood at 3 a.m.

Tolstoy tells this story: A gentleman stopping at a Russian inn noticed signs of insect life; after much cogitation he placed the four legs of his bed in bowls of water, and said with pride: "I've outwitted them!" But in the night he was aroused by sharp bites and found the clever bedbugs had run up the wall and dropped from the ceiling onto the bed. The traveler sorrowfully exclaimed: "They are too clever for me!" and passed the night pacing his room.

The next night was passed in a miserable village where absolutely no food was to be purchased. Another day or two of hard walking over sharp loess ravines brought the party to the wretchedly poor magistrate-town of Yen Chang. This lies in a narrow valley among brown sandstone hills. The petroleum is found oozing out of narrow seams not far above the small stream on whose banks the town is situated. The amount of oil collected in a day was only a quart at most. It was used for medicine, and, in times when the bean crop failed, for light. Oil geologists to whom the oil occurrence was described considered the chances of finding productive wells poor. But evidently the Standard Oil Company, with its larger experience, has thought more favorably of the prospect.

*Mining engineer, Palo Alto, California.

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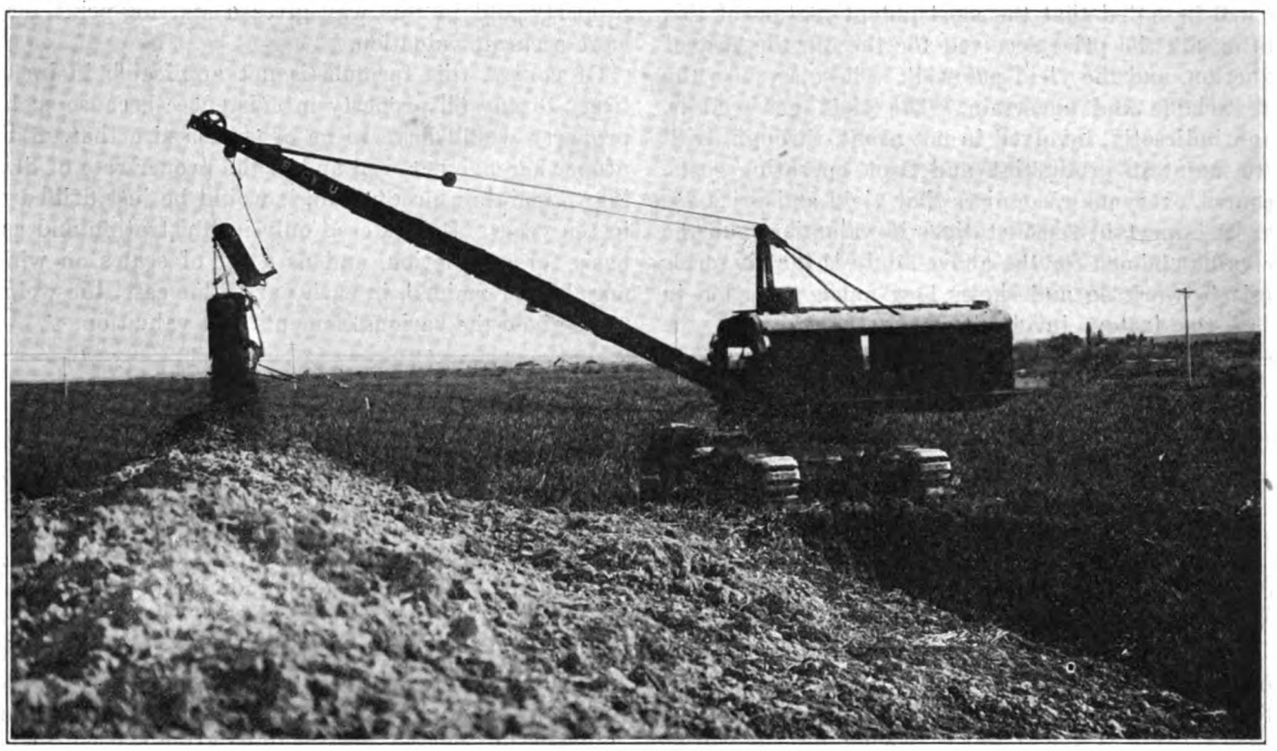

Construction of Drainage-System for Pioneer Irrigation District, Idaho*

The Pioneer irrigation district is organized under the laws of the State of Idaho and is situated in the Boise River valley in Ada and Canyon counties. The tract comprises 34,000 acres of irrigable lands, the greater portion of which has been irrigated for the past twenty years. The district is fairly compact and is approximately ten miles long and five miles wide. It has a slightly rolling surface with a general slope to the northwest of eight feet per mile. Above the district but in the same natural drainage basin, there is approximately 70,000 acres of irrigated land.

The soil of the tract consists of heavy loam on the surface, underlaid with from seven to twelve feet of either clay or hardpan, beneath which there are strata of sand and gravel or very coarse sand. The strata between the sand and gravel and the surface-loam contain a large quantity of alkali which kills practically all profitable agricultural crops when brought to the surface by ground-waters.

Water is secured by diverting the natural flow of the Boise river through the Caldwell and Phyllis canals. These systems provide an abundant supply during the first three months of the irrigating season, but during the late summer, the natural flow of the Boise river is low, and the prior rights cut down the available supply for the district to such an extent that there is insufficient water for the proper irrigation of the land. Consequently, a contract has been entered into with the Reclamation Service for a late season supply from the Arrowrock reservoir when completed.

Ground-water appeared in a few low areas along the main creek-beds during 1910. This was caused by seepage from the canals within the district and from the higher irrigated lands outside the district. The affected areas increased in number and size until in 1912 large swamps covered practically all the land in the low valleys. Much higher land was also made uncultivable because of the rise of the ground-water by capillary attraction, bringing large quantities of alkali to the surface. In all, between 5000 and 7000 acres of land was injuriously affected.

In the spring of 1912, the Secretary of the Interior authorized the Reclamation Service to investigate the drainage possibilities in the district as a part of a general drainage system for the Boise project. Transit and level lines were run along the main draws throughout the district, test-pits were dug, and a complete study made of the elevation of water-bearing strata and of ground-water. A system of open-cut drainage-ditches following the main draws and deep enough to reach the water-bearing strata was selected as the only feasible method to lower the ground water and to remove the surface-water coming from the land above the district. This required the construction of approximately 50 miles of open drains varying in depth from seven to fourteen feet and in bottom width from five to ten feet, with side-slopes of $1\frac{1}{2}$ to 1. The construction of the system included 2,000,000 cu. yd. excavation,

*From data furnished by F. T. Crowe, engineer U. S. Reclamation Service, Moran, Wyoming.

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13 concrete culverts, and 77 timber bridges. Smaller private and community drains were constructed by individuals to connect with the main system.

A contract was entered into between the Reclamation Service and the Pioneer irrigation district, by which the former undertook to construct the drainage system, the cost to be paid by the district in ten annual installments, without interest. Actual construction was commenced in November 1913, and the system was completed in the spring of 1915.

The excavation was done with three drag-line excavators having 1¼-cu. yd. buckets. The water throughout the district contains a large proportion of alkaline salts, making it unfit for boiler use. In addition, during a large part of the time, the excavators were working in swamps, where it was difficult if not impossible to drive a loaded wagon close enough to the machines to supply them with fuel. For these reasons, electric operation was selected. Power was secured from a 44,000-volt transmission-line that passes through the district. A field sub-station was placed on the line at a central point in the district, and the voltage reduced to 4000 volts. From this point, the current was delivered by means of temporary transmission-lines to sub-stations at the excavators. At these stations, the voltage is again reduced, the current finally reaching the motors at 440 volts. Power was purchased for 1c. per kilowatt-hour. The average amount of power used per cubic yard of material moved was 0.9 of a kilowatt-hour, the minimum, 0.39 of a kilowatt-hour, the latter where the digging was unusually easy.

The total weight of each machine was 55 tons. Caterpillar-traction was selected on account of the soft material over which the excavators had to travel. The caterpillar-tread had a bearing surface of 120 sq. ft., giving a bearing pressure of 920 lb. per sq. ft., but for a large part of the work, timber mattresses had to be laid for the machines. These gave a bearing surface of 320 sq. ft., or a pressure of 344 lb. per square foot.

Two styles of bucket were used on the work, the heavy-type Page bucket, and the Crowe bucket, the latter being specially designed for this work. It had a manganese-steel cutting edge on the bottom and sides, facilitating the sloping of the banks when hard-pan and tough gumbo was encountered. Another feature was a dumping device that enabled it to bring up a maximum load of 'soupy' material, such as accumulates in the bottom of a wet excavation.

The crew for each excavator was composed of one operator at $5 per day, one oiler at $3.25, and one laborer at $2.50. The operator was in responsible charge of the machine and crew during his shift and reported directly to the construction engineer. Three 8-hour shifts were worked.

Active competition was maintained between the individual operators on each machine and between the combined operators on the different machines. At the end of each shift the operator staked the ditch completed by him during the shift, each operator having different colored stakes. By this method the construction engineer on his daily inspection was able to check the quality of the work accomplished by each operator during the day, and each operator could estimate the amount and class of work accomplished by his fellow-operators. At the end of each month an operator's efficiency report, as shown below, was compiled. This was studied carefully by each operator and tended to

GROUND-WATER RELEASED BY DEEP DRAIN.

put life and interest into the work, as each operator's ambition was to have the best record.

OPERATOR'S EFFICIENCY REPORT

Record on 1¼-cu. yd. electric drag-line excavators, Boise project, March 1915.

NO. 1 DREDGE, SOLOMON SLOUGH DRAIN

Operator.	Amount excavated. Lineal ft.	Cu. yd.	Average number of cu. yd. excavated. Per hr.	Per shift.
Wirth	4,110	27,621	158.1	987.0
Higley, F.	4,680	30,947	155.7	998.0
Lilburn, A. J.	4,520	30,065	152.3	1,002.0
Total and average	13,310	88,633	155.3	996.0

Highest run in one shift: Wirth, 1436 cubic yards.

NO. 2 DREDGE, DIXIE DRAIN AND DRAIN FROM UPPER EMBANKMENT

Bates, S. H.	3,408	19,997	129.6	831.5
Stone, O.	4,076	24,786	127.7	953.5
O'Bryan, R.	3,688	22,781	124.0	813.5
Total and average	11,172	67,564	136.8	866.0

Highest run in one shift: Stone, 1287 cubic yards.

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No. 3 Dredge, Laht and Griffith Drain

Martin, W. H.....	3,306	27,630	189.6	1,151.0
Jennrich	3,363	28,836	180.3	1,202.0
Gibson, C. A.....	3,318	28,277	171.1	1,178.0
Total and average	9,987	84,743	180.3	1,176.0

Highest run in one shift: Martin, 1701 cubic yards.

Detailed costs for excavator No. 1 and a summary of the total cost for the entire work up to March 31, 1915, and for the month of March 1915, are as follows. The project was practically complete on March 31.

Electric Drag-Line No. 1

Operated from November 16, 1913, to March 31, 1915.

Items of work.	March 1915. Amount.	March 1915. Unit.	To date. Amount.	To date. Unit.
Excavation:				
Labor	$598.17	0.0067	$8,233.28	0.0108
Supplies and miscellaneous	129.61	0.0015	1,507.39	0.0020
Power	721.27	0.0081	6,819.44	0.0090
Repairs, labor	164.74	0.0019	3,492.99	0.0046
Repairs, materials and supplies	381.27	0.0043	4,110.47	0.0054
Cable (0.0015 cu. yd.)...	132.95	0.0015	1,136.83	0.0015
Drilling and blasting, labor	4.21	.....	378.60	0.0005
Excavating and blasting, supplies	120.75	0.0014	721.45	0.0010
Moving machine, labor....	924.40	0.0104	894.55	0.0012
Moving machine, supplies..	.....	.....	274.91	0.0004
Clearing right of way.....	2.24	.....	805.29	0.0011
Trimming banks	.....	.....	49.48	0.0001
Depreciation, on power and transmission lines	1,107.91	0.0125	9,473.60	0.0125
Depreciation on equipment.	1,551.08	0.0175	13,263.07	0.0175
Proportion of general installation cost	177.27	0.0020	1,515.78	0.0020
Engineering and superintendence	168.32	0.0019	2,469.59	0.0031
Accounts and records.....	13.33	0.0002	202.27	0.0003
Sub-total	$4,348.72	0.0491	$55,348.99	0.0730
Administration and general expense, 10%	434.87	0.0049	5,534.90	0.0073
Total, excavator No. 1...	$4,783.59	0.0540	$60,883.89	0.0803
Yardage excavated	88,633		757,688	

Machine efficiency:	March. Hours.	March. %	To date. Hours.	To date. %
Digging	570.45	78.4	6,779.00	75
Mechanical repairs..	91.15	12.5	1,204.45	13
Electrical repairs...	21.45	3.0	342.30	4
Moving	31.15	4.3	370.45	4
Power off	7.30	1.0	58.00	1
Blasting	5.30	0.8	283.00	3
Total	728.00	100.0	9,038.00	100

Mason Creek drain, 239,878 cu. yd., 36,931 lin. ft. of drain.
Noble Slough drain, 153,459 cu. yd., 28,956 lin. ft. of drain.
Purdum Slough drain, 125,640 cu. yd., 21,135 lin. ft. of drain.
Lower Mason Creek drain, 106,632 cu. yd, 17,000 lin. ft. of drain.
Solomon Slough drain, 132, 279 cu. yd., 24,475 lin. ft. of drain.

Summary

Features.	March 1915.	To date.
1. Investigations and surveys.....	$296.36	$9,572.83
2. Right-of-way	139.48	5,570.36
3. Excavation, machine No. 1:		
Mason Creek drain.....	.....	22,979.29
Purdum Slough drain.....	.....	9,337.25
Noble Slough drain.....	.....	10,224.30
Lower Mason Creek drain....	.....	9,179.24
Solomon Slough drain.....	4,783.59	9,163.81
4. Excavation, machine No. 2:		
Wilson Slough drain.....	.....	21,618.34
Elijah Slough drain.....	.....	18,510.09
Yankee Slough drain.....	.....	1,872.87
Dixie Slough drain.....	2,448.15	17,261.13
Deepening drain from upper embankment	1,846.85	1,846.85
5. Structures	2,467.51	52,423.29
Sub-total (feature cost).....	$11,981.94	$189,559.75
6. Power installation, balance undistributed	.....	7,287.79
7. Inventories, equipment on hand.	.....	4,399.09
Supplies on hand.....	.....	2,039.02
8. General installation, machine shop, balance undistributed..	.....	1,267.38
9. Administration and general expense, undistributed	.....	630.10
Total to date.....		$205,183.13

Total Results, Both Machines

	March. Quantity.	March. Cost.	To date. Quantity.	To date. Cost.
Amount excavated, cu. yd..	156,197	0.058	1,512,346	0.081
Amount excavated, lin. ft..	25,232	0.36	232,708	0.52

ORCHARD DROWNED BY GROUND-WATER.

The work was done under the general supervision of F. E. Weymouth, supervising engineer of the central division of the United States Reclamation Service with F. T. Crowe, construction engineer, in immediate charge of the work. J. L. Burkholder, assistant engineer, had charge of the surveys and ground-water studies, and of the collection of general drainage data in connection with the project. Measurements are being taken from time to time of the flow of water in the various drains. These indicate that the flow is decreasing with the gradual lowering of the ground-water level.

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Weight-Volumetric Proportioning of Concrete Aggregates in the Field

By J. A. KITTS*

The object of this article is to outline methods of determining, in the field, the proportion of voids and specific gravity of the given rock and sand and, with cement, for a concrete of maximum density. It can be shown that a concrete of maximum density, of the particular aggregates, gives the minimum cost per unit of strength and is the most satisfactory concrete from those materials. It is assumed that the aggregates pass the usual requirements for hardness, freedom from deleterious substances, size, etc., and the proportioning, not the selection of, material is considered.

The method of proportioning, herein described, applies, in a practical, expedient, and economical way, the findings of the laboratory tests, as described by the writer in WESTERN ENGINEERING for August 1915. A check is kept on the materials, and on the concrete as made in the field. The method furnishes a record of the materials and of the concrete such as is essential in good engineering construction.

Principles Involved in Proportioning Concrete. As a general rule, cement is the most costly material used in concrete, rock the least costly, and sand is somewhere between the two in point of cost. From a consideration of cost, then, sand and cement should not be used in excess. It is usually the case that the rock and sand possess greater strength than the neat-cement filling and binding medium. This indicates that, to develop strength, the rock fragments should abutt upon each other, as before mixing; the sand particles should fill the natural voids between the rocks and abutt upon each other; and the cement should fill the voids in the combined aggregates.

The relative adhesion between cement particle and rock and also between cement and sand particle, with reference to the cohesion of cement particle for cement particle, will tend to require an excess of cement if the adhesion is not good. In this event, the yield of sand-cement mortar would be greater than unity and the volume of rock should be proportionately increased so as to have rock voids equal to the volume of the sand-cement mortar. The specific gravity of rock, and of sand, usually ranges between 2.0 and 3.0, while that of the cement paste of 'work-consistency' is less than 2.0. This indicates that maximum density will obtain when the cement paste fills the voids without excess.

Proportioning, then, for maximum density and minimum cost per unit of strength, may be said to be a process of reduction of voids to a minimum. The reduction of voids is accomplished in several ways, some of which are as follows:

1. The voids in the rock are filled with sand and the voids in the sand filled with cement paste.
2. The voids are reduced by grading the material from fine to coarse and adding cement to fill the voids in the graded material, which is sometimes the run of the crusher.
3. The run of the crusher may not be satisfactory on account of the screenings, or material under ⅜-in. or ¼-in. diam., containing clay or other unsuitable material in appreciable proportions. In such cases, the screenings are thrown out and sand substituted in determined proportions.
4. The crushed rock is screened through three sizes of screen-openings, separated, and re-proportioned for minimum voids.
5. When bank gravel is used as the bulk of the aggregate, and the proportion of voids is high on account of an excess of sand, the voids are reduced by adding crushed rock in determined proportions and sizes.
6. Two sands may be available, one of fine grains and another of coarse grains. The two are combined in determined proportions to minimize the voids.

The method of reduction of voids particularly within the scope of this article is that of (1), but the weight-volumetric determinations may be adapted to the other methods.

Examples of Proportions of Mixtures with Regard to Voids. Assuming that we have a rock aggregate of 33% voids and a sand aggregate of 50% voids and mix them, with cement, in the volumetric proportions of 1:3:6, the cement would be only ⅔ of the volume of voids in the sand and the volume of sand would be 1½ times the volume of voids in the rock. The rock is displaced by porous, more costly, sand-cement mortar, a decidedly poorer material from every point of view. The result is a permeable, weak, and more costly concrete. The mixture should be 1:2:6, the cement being 50% of the volume of sand and the sand being 33% of the volume of rock.

Again, if these materials were mixed in the volumetric proportions of 1:2:4, the sand-cement mortar would be in the proper proportions, but the sand would still be 150% of the voids in the rock. It is safe to say that the 1:2:6 mixture will develop more strength than either the 1:2:4 or 1:3:6 mixtures, because, in the case of the former, the rocks do not abutt upon each other, and in the latter the rocks not only do not abutt upon each other but are filled with a porous mortar.

If we had a rock of 50% voids and a sand of 33% voids, the proper proportions would be 1:3:6, the cement being 33% of the volume of sand, or equal to the volume of voids in the sand, and the sand being

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50% of the volume of rocks, or equal to the volume of voids in the rock. If these materials were mixed in 1:2:4 proportions, the volume of cement would be 150% of the volume of voids in the sand, the yield of sand-cement mortar would be approximately 1.17, or a volume of 2.33, and the volume of mortar would be 117% of the voids in the rock. It is doubtful whether or not the 1:2:4 mixture would be stronger than the 1:3:6 mixture. The latter mixture would show lower cost per unit of strength and greater density.

Field Determination of Specific Gravity and Proportion of Voids. To determine, in the field, the proportion of voids and the specific gravity of the materials, the apparatus must be simple and the methods expedient. The following apparatus and methods are suggested:

Apparatus: Scales, water-bucket, and sheet of canvas.

Method: 1. Weigh bucket (a).

2. Weigh, individually, 5 or 10 buckets of material sampled from the storage pile (b). Add a few buckets for wastage and thoroughly sun-dry the material.

3. Fill bucket with water and weigh (c).

4. Dry the bucket and fill it with dried material, carefully screening the same level with the top of the bucket, and weigh (d). Pour out material on tough paper or canvas.

5. Fill bucket about one-fourth full of water and pour in material from canvas. Add water to bring same to brim of bucket, weigh (e).

6. Tabulate weighings as follows:

Job: Material: Date: By:

	a	b.	c	d.	e	f.	g	h.	i.
	Weight of Bucket.	Weight of Bucket and Moist Material.	Weight of Bucket and Water.	Weight of Bucket and dry Material.	Weight of Bucket Material and Water.	Voids. $\frac{e-d}{c-a}$	Apparent Specific Gravity. $\frac{d-a}{c-a}$	Specific Gravity. $\frac{g}{1-f}$	Proportion of Water In Moist Material. $\frac{b-d}{c-a}$
1.									
2.									
3.									
4.									
5.									

The following equations are involved in the above determinations:

Equations (metric weights and measures):

(1) Volume of vessel (litres) = weight of water (kilos).

(2) Proportion of voids =

$$\frac{\text{Weight of water filling voids (kilos)}}{\text{Volume of vessel (litres)}}$$

(3) Apparent specific gravity of material =

$$\frac{\text{Weight of material (kilos)}}{\text{Volume of vessel (litres)}}$$

(4) Specific gravity of material =

$$\frac{\text{Apparent specific gravity}}{\text{1—Proportion of voids}}$$

United States weights and measures:

(5) Volume of vessel in cubic feet =

$$\frac{\text{Weight of water in pounds}}{62.42}$$

(6) Proportion of voids =

$$\frac{\text{Weight of water filling voids in pounds}}{\text{Volume of vessel in cubic feet times 62.42}}$$

(7) Apparent specific gravity of material =

$$\frac{\text{Weight of material in pounds}}{\text{Volume of vessel in cubic feet times 62.42}}$$

The material is poured into the water in operation No. 5 to prevent trapping of air, which would occur if the water was poured into the material. The refinements of repetition, etc., will suggest themselves.

Having determined the proportion of voids in the rock and sand, the mixing for maximum density may be taken from the following table:

The proportions in the table are computed by equations (8) and (9) following:

(8) $$\frac{\text{Proportion of sand}}{\text{Unit proportion of cement}} = \frac{1}{\text{Proportion of voids in sand}}$$

(9) Proportion of rock =

$$\frac{\text{Proportion of sand from equation (8)}}{\text{Proportion of voids in rock}}$$

In case it is necessary to use a proportion of cement in excess of the voids in the sand, in order to secure satisfactory strength, the yield of sand-cement mortar should be taken into consideration. The yield of mortar may be approximately stated as follows:

(10) Yield of mortar =

$$\frac{\text{Proportion of sand—proportion of cement—proportion of sand (Voids in sand)}}{\text{Proportion of sand}}$$

$$= 1 - \frac{\text{Proportion of cement—(proportion of sand times voids)}}{\text{Proportion of sand}}$$

Equation (9) then becomes:

(11) Proportion of rock =

$$\frac{\text{Proportion of sand times yield of mortar}}{\text{Proportion of voids in rock}}$$

Example: given; rock, 50% voids; sand, 33% voids. Required that sand-cement mortar be mixed in 1:2 volumetric proportions. To find the proportion of rock.

$$\text{Yield of mortar} = 1 \div \frac{1-2(0.33)}{2} = 1.17 \text{ and}$$

$$\text{Proportion of rock} = \frac{2 \times 1.17}{0.50} = 4.68.$$

The proportions will then be 1:2:4.7 and the yield of concrete will be approximately equal to unity.

The yield of mortar is determined on the basis that the volume of sand is unity. If the volume of mortar is equal to the volume of sand used, the yield is 1.0.

'Yield of concrete' is similarly based on the volume of rock as unity. It is our object in proportioning for maximum density to keep the yield of concrete as near unity as possible.

Proportioning for the Mixer. It is important that the mixer be run to capacity and that the volume of concrete turned out with each batch be known with a certain degree of accuracy. The volumes for a full batch may be determined as follows:

(12) Volume of rock = $\frac{\text{Capacity of mixer}}{\text{Yield of concrete}}$

(13) Volume of sand =

$$\frac{\text{Capacity of mixer times proportion of sand}}{\text{Proportion of rock times yield of concrete}}$$

(14) Volume of cement =

$$\frac{\text{Capacity of mixer times proportion of cement}}{\text{Proportion of rock times yield of concrete}}$$

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Table Of Proportions.

Voids in Stone.	Voids In Sand.																							
	.27	.28	.29	.30	.31	.32	.33	.34	.35	.36	.37	.38	.39	.40	.41	.42	.43	.44	.45	.46	.47	.48	.49	.50
	Proportions of Mortar.																							
	1 to 3.70	1 to 3.57	1 to 3.45	1 to 3.33	1 to 3.23	1 to 3.12	1 to 3	1 to 2.94	1 to 2.86	1 to 2.78	1 to 2.70	1 to 2.63	1 to 2.56	1 to 2.5	1 to 2.44	1 to 2.38	1 to 2.33	1 to 2.27	1 to 2.22	1 to 2.17	1 to 2.13	1 to 2.08	1 to 2.04	1 to 2
	Proportions of Rock.																							
.27	13.7	13.2	12.7	12.3	12.0	11.6	11.1	10.9	10.6	10.3	10.0	9.7	9.5	9.2	9.0	8.8	8.6	8.4	8.2	8.0	7.9	7.7	7.6	7.4
.28	13.2	12.7	12.5	11.9	11.5	11.1	10.7	10.5	10.2	10.0	9.6	9.4	9.1	8.9	8.7	8.5	8.3	8.1	7.9	7.8	7.6	7.4	7.3	7.1
.29	12.7	12.3	11.9	11.5	11.1	10.7	10.3	10.1	9.9	9.6	9.3	9.1	8.8	8.6	8.5	8.2	8.0	7.8	7.7	7.5	7.3	7.2	7.0	6.9
.30	12.3	11.9	11.5	11.1	10.7	10.4	10.0	9.8	9.5	9.3	9.0	8.8	8.5	8.3	8.1	7.9	7.7	7.6	7.4	7.2	7.1	6.9	6.8	6.7
.31	11.9	11.5	11.1	10.8	10.4	10.1	9.7	9.5	9.2	9.0	8.7	8.5	8.3	8.1	7.9	7.7	7.5	7.3	7.2	7.0	6.9	6.7	6.6	6.5
.32	11.6	11.2	10.8	10.4	10.1	9.8	9.4	9.2	8.9	8.7	8.4	8.2	8.0	7.8	7.6	7.4	7.3	7.1	6.9	6.8	6.7	6.5	6.4	6.3
.33	11.2	10.9	10.5	10.1	9.8	9.5	9.1	8.9	8.7	8.4	8.2	8.0	7.8	7.6	7.4	7.2	7.0	6.9	6.7	6.6	6.4	6.3	6.2	6.1
.34	10.9	10.5	10.1	9.8	9.5	9.2	8.8	8.6	8.4	8.2	7.9	7.7	7.5	7.3	7.2	7.0	6.8	6.7	6.5	6.4	6.3	6.1	6.0	5.9
.35	10.6	10.3	9.9	9.5	9.3	8.9	8.6	8.4	8.2	7.9	7.7	7.8	7.3	7.1	7.0	6.8	6.6	6.5	6.3	6.2	6.1	5.9	5.8	5.7
.36	10.3	9.9	9.6	9.3	9.0	8.7	8.3	8.2	8.0	7.7	7.5	7.3	7.1	6.9	6.8	6.6	6.5	6.3	6.2	6.0	5.9	5.7	5.7	5.6
.37	10.0	9.7	9.3	9.0	8.7	8.5	8.1	7.9	7.7	7.5	7.3	7.1	8.9	6.8	6.6	6.4	6.3	6.1	6.0	5.9	5.8	5.6	5.5	5.4
.38	9.7	9.4	9.1	8.8	8.5	8.2	7.9	7.7	7.5	7.3	7.1	6.9	6.7	6.6	6.4	6.3	6.1	6.0	5.8	5.7	5.6	5.5	5.4	5.3
.39	9.5	9.2	8.8	8.5	8.3	8.0	7.7	7.5	7.3	7.1	6.9	6.7	6.6	6.4	6.3	6.1	6.0	5.8	5.7	5.6	5.5	5.3	5.2	5.1
.40	9.3	8.9	8.6	8.3	8.1	7.8	7.5	7.3	7.1	7.0	6.8	6.6	6.4	6.2	6.1	6.0	5.8	5.7	5.6	5.4	5.3	5.2	5.1	5.0
.41	9.0	8.7	8.4	8.1	7.9	7.6	7.3	7.2	7.0	6.8	6.6	6.5	6.2	6.1	6.0	5.8	5.7	5.5	5.4	5.3	5.2	5.1	5.0	4.9
.42	8.8	8.5	8.2	7.9	7.7	7.4	7.1	7.0	6.8	6.6	6.4	6.3	6.1	5.9	5.8	5.7	5.5	5.4	5.3	5.2	5.1	5.0	4.9	4.8
.43	8.6	8.3	8.0	7.7	7.5	7.3	7.0	6.8	6.6	6.5	6.3	6.1	6.0	5.6	5.7	5.5	5.4	5.3	5.2	5.1	5.0	4.8	4.7	4.7
.44	8.4	8.1	7.8	7.6	7.3	7.1	6.8	6.7	6.5	6.3	6.1	6.0	5.8	5.7	5.5	5.4	5.3	5.2	5.0	4.9	4.8	4.7	4.6	4.5
.45	8.2	7.9	7.6	7.4	7.2	6.9	6.7	6.5	6.3	6.2	6.0	5.8	5.7	5.5	5.4	5.3	5.2	5.0	4.9	4.8	4.7	4.6	4.5	4.4
.46	8.0	7.8	7.5	7.2	7.0	6.8	6.5	6.4	6.2	6.0	5.9	5.7	5.6	5.4	5.3	5.2	5.1	4.9	4.8	4.7	4.6	4.5	4.3	4.3
.47	7.9	7.7	7.3	7.1	6.9	6.6	6.4	6.3	6.1	5.9	5.7	5.6	5.5	5.3	5.2	5.1	5.0	4.8	4.7	4.6	4.5	4.4	4.3	4.3
.48	7.7	7.4	7.2	6.9	6.7	6.5	6.2	6.1	6.0	5.8	5.6	5.5	5.3	5.2	5.1	5.0	4.8	4.7	4.8	4.5	4.4	4.3	4.2	4.2
.49	7.5	7.3	7.0	6.8	6.6	6.4	6.1	6.0	5.8	5.7	5.5	5.4	5.2	5.1	5.0	4.9	4.7	4.6	4.5	4.4	4.3	4.9	4.2	4.1
.50	7.4	7.1	6.9	6.7	6.4	6.2	6.0	5.9	5.7	5.6	5.4	5.3	5.1	5.0	4.9	4.8	4.6	4.5	4.4	4.3	4.2	4.2	4.1	4.0

FIG. 1. TABLE FOR VOLUMETRIC PROPORTIONING.

Example: If we have a mixer with a capacity of 27 cu. ft. and wish to use a mixture of 1:2:4.7, with a yield of concrete of unity, then:

Volume of rock $= 27/1 = 27$ cu. ft.

Volume of sand $= 27 \times 2/4.7 \times 1 = 11.5$ cu. ft.

Volume of cement $= 27 \times 1/4.7 \times 1 = 5.7$ cu. ft.

As 94 pounds, or one sack, of cement makes 1 cu. ft. of cement paste of 'work consistency,' the quantities would be: 6 sacks, or 564 pounds, of cement, 11.5 cu. ft. of sand, and 27 cu. ft. of rock.

Checking the Volumes of Material by Weighing. The difficulty of using the exact quantities, or even approximating them, remains. This difficulty is more apparent than real. If the material is brought to the mixer in barrows, the volume of material in the barrows may be checked occasionally, by weighing, using the following equation:

(15) Weight of volume required per barrow = volume required in cu. ft. times apparent specific gravity of moist material times 62.42.

Conclusions. If the strength of the concrete is in question, either because the proportions as determined by this method, are unusual, or the materials are unusual, it is recommended that accurate laboratory tests be made to determine proportions satisfying the strength and other requirements. If the concrete is to perform the compression function in reinforced concrete, it is essential that accurate laboratory tests be made to determine the satisfactory proportions and the strength factor to be used in the design. It is not economical to design for a concrete of 2000 lb. per sq. in. compressive strength and use a concrete with a strength of 3000 lb. per sq. in. There is no economy in poor and cheap concrete, often resulting in the failure of the structure.

Concrete has the reputation in various quarters of being an uncertain structural material, but if a little care and mathematics is applied to the testing and proportioning of the materials, concrete structures may be designed with the same assurance as those of steel.

PLOWING OLD MACADAM WITH A TRACTOR IN CONSTRUCTION OF A NEW CONCRETE ROAD

In building 24,000 ft. of concrete road on Milwaukee avenue, near Niles Center, Illinois, the existing 14-ft. macadam highway was plowed to a depth of 12 in. by a tractor. Moving at its intermediate speed of 2½ miles per hour the tractor covered an area 1¼ miles long and 20 ft. wide in an eight-hour day. This, according to the contractor, equalled the work of 100 horses. The average daily operating cost for plowing and grading was $16, which included $5 for 45 gallons of gasoline and $11 for labor, $5 for the engineer on the tractor, and $6 for the two plowmen, or approximately one-tenth of a cent per square yard.

The new concrete road is 18 ft. wide, with 6-ft. earth shoulders. The concrete is laid on the flat sub-grade in one course, six inches at the sides and 8 inches in the centre, thus giving a top crown of two inches. The mix consisted of one part portland cement, two parts sand, and three and one-half parts gravel. The gravel ranged in size from ¼ in. to 1½ in. diam. The concrete was placed at an average rate of 800 cu. yd. per day. Clastite joints are spaced every 100 ft. A well and reservoir were placed near the middle point of the work. One pump raised the water from the well to the reservoir and a second pump forced it from the reservoir into a 2-in. pipe which carried the water 12,000 ft. from the well in both directions.

The equipment used in building the road consisted of a ½-yd. Koehring mixer, a three-speed, 65-hp. Bullock tractor, and an Austin roller and 7-ft. grader. The road was built jointly by the county and the State. W. S. Walters, of Glencoe, Illinois, was the contractor.—*The Highway Magazine.*

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California Petroleum and the European War

By J. H. G. WOLF*

All industries wherever situated, have been vitally affected by the European war prevailing since July 1914. Some few, such as those dealing in arms and munitions, have been affected favorably, but the business world at large has suffered losses ranging from a slight or unimportant degree on the one hand to total extinction on the other. The notes presented herewith attempt to show the loss sustained by one of the fundamental industries of the Pacific Coast, that of California petroleum.

The accompanying diagram presents the record to July 1, 1915, of the production, shipments, and stocks of crude petroleum since January 1, 1910, or the period just prior to the bringing in of the first Lakeview well, an epochal point in the oil business of the State. The curves show at a glance the trend of the controlling factors of the business during this period. By October 1913, production and consumption had reached a fairly uniform volume of 270,000 bbl. per day. The stocks or surplus oil in storage had reached 50,000,000 bbl., as against 21,000,000 bbl. in January 1910, and this quantity seemed destined to remain fairly constant. The production and consumption curves, however, continued to point upward, presenting an almost uniform increment or expansion from January 1910, onward. By July 1914, they reached 300,000 bbl. per day and there was no reason to expect that capacity figures had been reached or exceeded.

With the outbreak of hostilities in Europe in July, however, and the consequent curtailment of business throughout the world, there was a sharp break in both of these curves, which curves did not find constant bearings until about January 1915, when they settled to and have been maintained since at about 250,000 bbl. each per day. This was also the quantity produced and consumed in April 1913. In other words, we are back now at the point that we had reached 27 months ago in the efforts to establish a market for the immense volume of new oil brought into the market with the discovery of the great Midway field. The falling off in production and consumption can be expressed in another way by stating that the net loss of 50,000 bbl. per day meant a drop of one-sixth in volume of the business transacted. The production for the half year just passed (January 1 to July 1, 1915) was 44,681,816 bbl. and the shipments were 43,386,310 bbl. The indications therefore are that the California production for the calendar year of 1915 as compared with the calendar year of 1914 will show a drop of possibly 10,000,000 barrels. The market reports for July and August, or the period since the diagram was constructed, show no sensible change in the production and shipment figures for the first half year of 1915, which are shown in the diagram.

The mere loss of 16⅔% of production and shipments is not however the full measure of the loss sustained by the industry; 10,000,000 bbl. has been added to the stocks or storage figures and the consequence of this addition to an already sufficient surplus to carry the business will be felt for some time to come. The losses incidental to carrying a large surplus of oil over and above the quantity that is legitimately required as a reserve to carry the business, are felt through all the branches of both the producing and consuming sides of the industry. It is against these losses that the best efforts of conservation can be directed. These losses include waste caused by evaporation of the oil in storage, the first cost of building the containers and interest charges, the first cost of the oil itself and interest charges, and finally the unnatural depression of price of the current production because of the presence on the market of a gross oversupply. There appear to be no compensating gains for any of these losses. If the statement that the 10,000,000 bbl. added to the already sufficient storage, is demoralizing, needs outward support, it is readily supplied by the recent report in the daily press which noted that "the Harbor Commission of San Francisco had just let a contract for fuel oil for the two years (hence) at 58c. a barrel," or $3.77 per ton. Such prices for a staple like petroleum delivered 300 miles away from the point of its origin means but one thing; that the industry, so far as the producer is concerned, which includes ultimately the consumer, is in an unsatisfactory state. This is a continuation of the conditions which have obtained for the past four years, where the producer at large has received less than the cost of production per barrel at the well, considering all the factors which enter into cost.

Influences in general but little considered contribute much to the prevailing depression if not demoralization, which are entirely apart from the European War, or the business disruption in this country. Most important is the continued indiscriminate development by operators in the face of the heavy overproduction and accumulation of stocks. If all operators stopped all drilling for the period of one year, the natural decline in yield of individual wells, amounting annually to not less than 15%, would solve the immediate problem. True conservation could not be served by a simpler or readier measure. The continued drilling during the past year or two, has been mainly by a few of the dominant companies that possess large areas of land and at the same time buy and transport oil. The operator

*Mills Bdg., San Francisco.

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who produces only, is powerless to defend himself against the policies of these companies. There seems to be but one sure remedy to cure the latter situation, and that is for the individual producers to put themselves in a similar position, namely: to combine or merge their small company operations and share the fortunes and the hazards incident to the industry in all its phases. A merger of this character, based on the results of the valuation work of the past year of the Independent Producers Agency, is reliably reported to be under way.

The authority for the statistical data upon which the curves of the diagram are constructed is the Independent Producers Agency of California, and the figures used are those published in the oil papers. Each of the dominant corporations in the business maintains an elaborate statistical department. These corporations not only produce oil but also buy oil from other producers, transport, refine, and sell the unrefined as well as the finished product. They include the Standard Oil Company, the General Petroleum Company, the

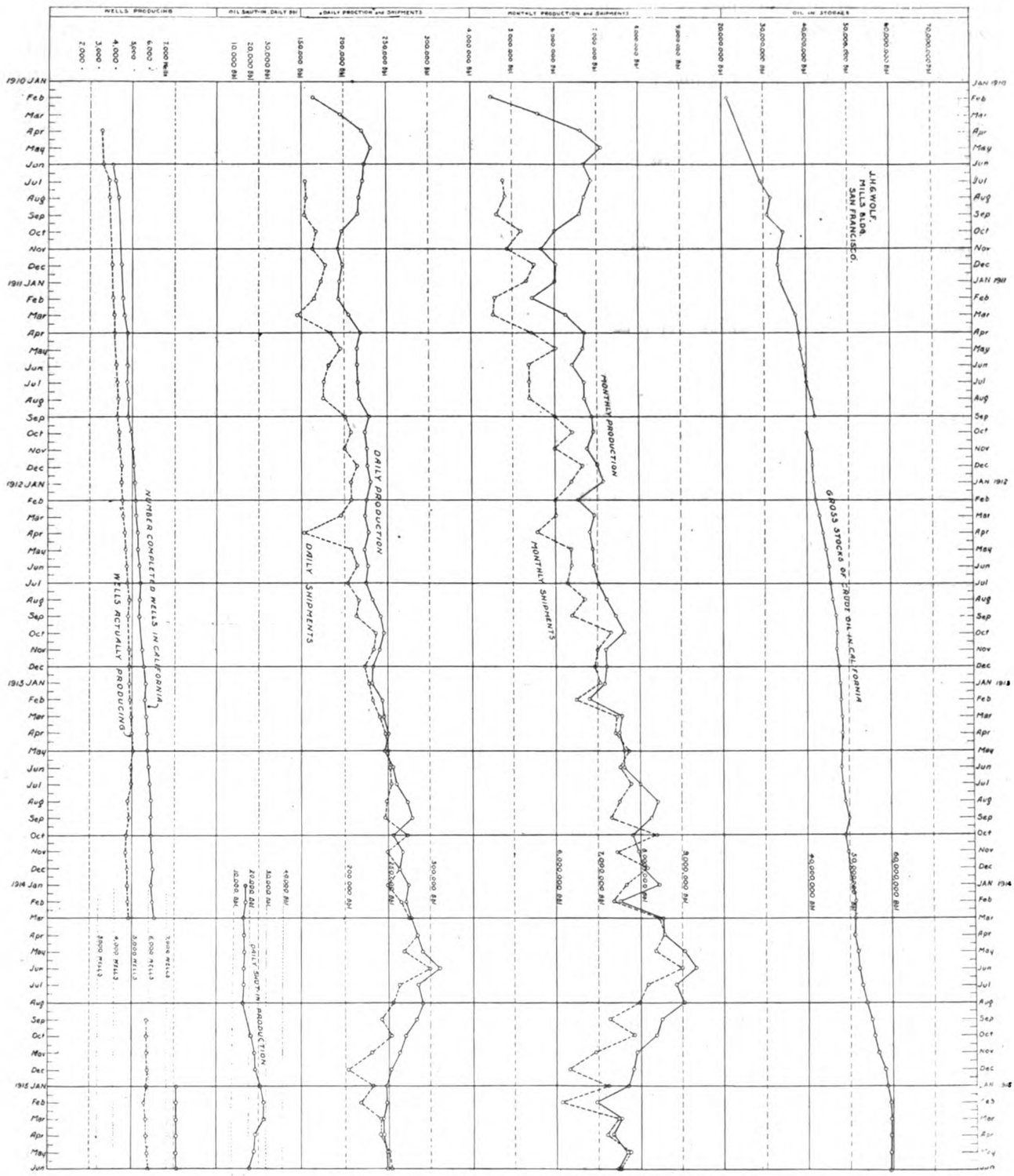

CHART OF CALIFORNIA PRODUCTION, SHIPMENTS, ETC.

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Associated Oil Company, the Shell Company, the Union Oil Company and the Independent Producers Agency. The Union Oil Company has a marketing agreement with the Agency. The Kern Trading & Oil Co., also one of the dominant factors and the claimant to and operator upon the largest amount of oil land in the State, is one of the heaviest producers and shippers, as well as buyers. This corporation is the fuel department of the Southern Pacific railroad and the oil it produces and buys is consumed by the railroad.

A condensed statement or résumé of the general production and shipment figures is given out each month by the Agency. The Standard Oil Company issues a monthly bulletin called 'The Standard Oil Bulletin' in which is published a similar résumé of the situation. The figures put out by these two concerns while varying from month to month in some particulars, do not differ essentially over a longer period, except as to the important item of stocks. The latter figure, according to the Agency, on July 1, 1915, was 59,554,625 bbl. while the Standard's estimate was 60,616,286 bbl. or a difference of approximately 1,000,000 bbl. Production figures are the gross figures and include the oil used as fuel in the fields; shipments include field-fuel as well as the oil used elsewhere. Referring to the well-data of the diagram, the breaks shown represent a change in the method adopted for figuring the total number of active producing wells. Previous to 1914 the 500 and odd wells of the old Los Angeles City and the Summerland fields were not reckoned as active, even though producing, because they are practically spent wells.

The new Maddux bill, the so-called new water-law, passed at the recent session of the state legislature and providing for the control of the water question in the case of drilling as well as pumping wells, carries a provision that producers shall render regular statistical data to the State Mining Bureau. If this provision, Section 20 of the bill, can be made effective, the public may receive through the State Mining Bureau, some detailed statistical data not now available. It is hardly likely, however, that the accuracy of the general figures now published will be altered.

The oil-trade of this Coast, like that of the Atlantic Coast, has seen numerous fundamental changes during the War period. Local importation of refined products from the Orient through the Shell company is reported to have practically ceased, as has also the bringing in of high-grade crude oil from Peru. On the export side of the market, the completion of the Panama canal and the tying up of the nitrate industry of Chile has reduced the volume of export southward on the Pacific, but trade continues to increase steadily on the North Pacific coast. The volume of oil now received at Puget Sound and at British Columbia ports is so heavy as seriously to embarrass the coal mines of the Northwest, many of these being closed entirely. In Canada there is an agitation to impose a heavy import duty on oil to prevent further demoralization of the coal trade. This move might check the volume of imports somewhat but its effect would probably be only temporary. The railroads and steamships are the principal users, and competitive conditions, as well as the individual money-saving, compel users to continue with oil-fuel when once adopted, and to adopt it wherever practicable. In the State of Washington, there is an agitation to impose some state taxation on crude oil, a discrimination hardly to be countenanced by law.

The effect of the war holocaust abroad is ramifying and is more real than apparent or measurable in many lines. In its relation to California petroleum, its effect has been serious and will probably be so for some time to come. Probably the only beneficial effect will be to broaden the ultimate market for fuel oil through its increased use by shipping, and to hasten the merging of the small independent producers with one or more of the dominant factors of the business, allowing thereby an immediate reduction of current excess production by the shutting down of needless wells. In the rebuilding of the destroyed merchant ships of the various European nations, the Diesel-engine vessel will be preferred because competitive conditions demand this recognition. The further reason, the guaranteeing of the sufficiency of the fuel supply, is found in the fact that the wonderful fields of the East coast of Mexico, which are only beginning to be tapped and which in general produce oil of fuel-grade, assure an abundant supply of crude oil for these ships on the Atlantic, just as the California fields do on the Pacific ocean. Oil depots are becoming as common as coal depots on every avenue of the world's commercial trade routes; this present war has shown the advantage of the oil-burning vessel and it is probable that few coal-burning war-craft will be constructed in the future.

MILL TAILING FOR ROAD-METAL

In Missouri a considerable amount of road-material is obtained from the tailing of the concentrating-mills at the zinc mines. This materal, which is put on the market as 'chats,' consists of small angular fragments of chert and limestone. The zinc companies are glad to get rid of this waste material, which is loaded on the cars by the railroads of the district at a cost of about six or eight cents per ton. It is a good road-material and is widely distributed through the Middle West. It sells in most places at prices ranging from 50 cents to $1 per ton, but in the neighborhood of the mines it can be had for about 15c. per ton. It is used for railroad ballast as well as road-making. The annual output, according to the United States Geological Survey, amounts to about 1,300,000 tons.

In Tennessee and Alabama a quantity of chert is used for road-metal, and in many States crushed slag from blast-furnaces also furnishes a valuable road-material. In Alabama, one of the large iron-producing States, over 2,000,000 short tons of furnace slag, with an average value of 25c. per ton, was crushed and put on the roads last year. Crushed slag is also used as railroad ballast and for concrete and roofing material.

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PROGRAM OF AMERICAN BUILDERS' WEEK

From the standpoint of the engineer, American Builders' Week, which is to be celebrated at San Francisco, October 18 to 23, will be one of the most interesting conventions of the Exposition year. The General Contractors' Association of San Francisco has taken charge of all arrangements, which are being made under the direction of E. T. Thurston, 57 Post street, San Francisco. Headquarters of the convention are to be at the Palace Hotel. Besides the addresses listed on the accompanying program, there will be a large number of social events as well as excursions to near-by points of interest. On Thursday morning, October 21, there will be a parade illustrating the importance and the development of the building industry. The technical program follows below:

TUESDAY, OCTOBER 19

10:00 a.m.

Opening of Congress at the Municipal Auditorium.

Addresses of welcome by Hiram W. Johnson, governor of California; James Rolph, mayor of San Francisco; Charles C. Moore, president Panama-Pacific International Exposition.

2.00 p.m.—Technical Addresses

Organization as Applied to Construction Work

Major-General George A. Goethals.

The American Builder

R. Clipston Sturgis, president American Institute of Architects.

National Organization in the Building Industry—Its Need

H. L. Lewman, president National Association of Builders' Exchanges.

The Building Business as a Factor in the Commercial Life of the Country

Charles W. Gindele, president of the Building Construction Employers' Association of Chicago.

The Engineering Contractor

Halbert P. Gillette, editor-in-chief of *Engineering and Contracting.*

WEDNESDAY, OCTOBER 20

2:30 p.m.—Address

Clay Products and Their Modern Application

Walter E. Dennison, second vice-president National Terra Cotta Society.

The Fireproof Value of Concrete

Lewis R. Ferguson, assistant secretary National Association of Portland Cement Manufacturers.

Metal Products as Applied in Buildings

John B. Leonard, M. Am. Soc. C. E.

THURSDAY, OCTOBER 21

3:00 p.m.

The Efficient Conduct of Building Operations

Grant Fee, president of Building Trades Employers' Association of San Francisco.

4:00 p.m.

Bonding the Builder—Its Origin and Present Effect Upon Building Contracts

Henry A. Jacobs, attorney for the California Building Laws Association.

8:00 p.m.

Opening Bids in Public as Essential to Proper Business Conditions

George W. Kelham, chief of architecture, Panama-Pacific International Exposition.

9:00 p.m.

Economic Side of Fire Protection

John C. McCaughern, district manager Board of Fire Underwriters of San Francisco.

FRIDAY, OCTOBER 22

10:00 a.m.

The Building and Maintenance of Good State Highways and Bridges

A. B. Fletcher, State highway engineer.

11:00 a.m.

Men Who Build and Their Legal Responsibilities

John L. McNab.

2:00 p.m.

Electricity as a Factor in Building Construction

John A. Britton, vice-president and general manager Pacific Gas and Electric Company.

3:00 p.m.

Pacific Coast Lumber at Home and Abroad

R. A. Hiscock.

8:00 p.m.

Modern Plumbing in Its Relation to Building Construction

John L. E. Firmin, state secretary Association of Master Plumbers of California.

9:00 p.m.

The Building Contractor and the Architect

Felix Kahn.

Railroad construction in Canada reached a maximum two years ago when two transcontinental lines were being built and a third extended. The employment of many thousands of men on this work gave a great impetus to the demand for machinery, foodstuffs, and general supplies. This continued for some time. The three transcontinental roads are now practically completed. It would be unreasonable to look again for the abnormal activity in this direction. But a greater railroad mileage is now under construction than in the United States. About 2800 men are employed on the Hudson Bay railway, 418 miles long. About 290 miles of the line has been graded, steel is 75 miles and ballasting about 100 miles behind that. The line is to be finished in 1916, including considerable work at Port Nelson harbor, as well as the construction of several bridges. The Canada Central railway has over 1200 men at work on a 59-mile stretch in the Peace River district, and the Alberta & Great Waterways railway has 1500 men at work on its line, 165 miles long, to Fort McMurray. The Bassano & Bow River railway is beginning construction and the Canadian Northern railway has about a thousand men on its different branches in Alberta. The Edmonton, Dunvegan & British Columbia railway is building 65 miles this year and the Pacific Great Eastern has 1100 men at work on its line to Fort George.—*Canadian Engineer.*

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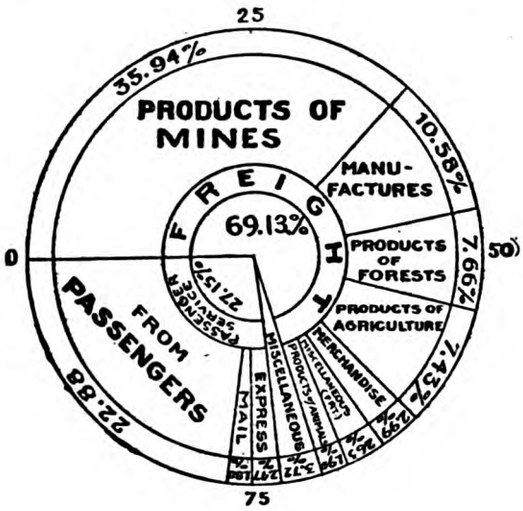
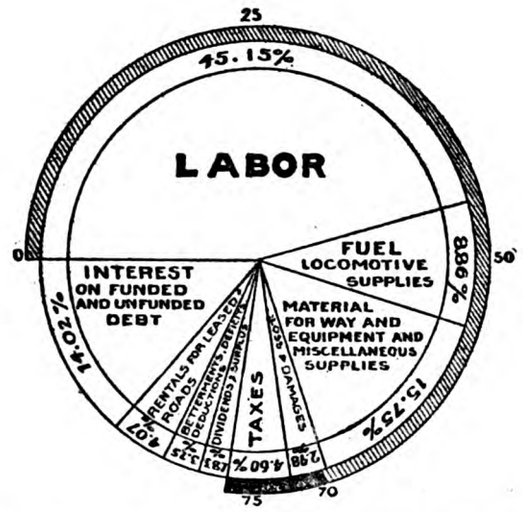
RECEIPTS AND EXPENDITURES OF AMERICAN RAILROADS

The accompanying diagrams show the proportion of receipts of railroads from various sources and similar data for the expenditures, compiled by Slason Thompson, of the Bureau of Railway News and Statis-





tics, for the year ending June 30, 1914. During this period the total revenue of railroads (225,486 miles) in the United States was $2,991,398,735. Freight contributed $2,061,262,870. In 1912, the aggregate capacity of 2,215,549 freight-cars was 82,965,418 tons, or 37 tons each. The railroads in 1912 moved products of mines totaling 566,538,387 tons. Of this, 315,581,446 tons was in the Eastern, 97,535,577 tons in the Southern, and 153,421,364 tons in the Western districts.

Wrought tungsten has been substituted with success for platinum and platinum-iridium as contact points in spark coils, voltage regulators, telegraph relays, etc. The service far exceeds that for platinum and platinum-iridium contacts, due to the greater hardness, higher heat conductivity, and lower vapor pressure of tungsten as compared with platinum.—*Mechanical World.*

Hints on Practice

BLASTING HINTS

In loading short holes with a tamping stick, many powdermen make a mark or notch on the stick, to indicate the distance from the collar of the hole to the top of the pocket or chamber. By this means they can tell when the pocket is loaded and when the charge begins to rise in the borehole. It is also a good idea to make a mark, or place a rubber band around the tamping-stick, opposite the collar or mouth of the hole when the stick rests on the top of the charge when finished. The distance between this mark and the end of the tamping-stick will give the amount of tamping in the hole so that in the event of a misfire, it will be possible to remove nearly all of the tamping without danger of digging into the explosive. The tamping-stick, of whatever material, should not be a close fit in the borehole, as in loading holes full of water, where the tamping-stick fits the borehole snugly, misfires have occurred, in tamping the hole, from the piston effect forcing the water into the electric blasting-cap.

In loading deep well-drill holes, where it is not practicable to use a pole, a tamping-block of hardwood, attached to a rope, is used. This block should not be weighted unless the holes have water in them. When weighted, a hole about 1½ in. diam. is bored in the centre of the block. A quantity of molten lead or babbit metal is then poured in and the opening plugged with a wooden plug in such a way that no metal is exposed. These plugs are usually about an inch smaller than the diameter of the drill-bit and from 3 to 4 feet long. The rope, for convenience and safety, is passed over an open block or pulley, supported by a tripod seven or eight feet high over the centre of the borehole.—*Du Pont Magazine.*

Engineers' Note Book

DIAGRAM FOR THE CALCULATION OF WATER-POWER REQUIRED FOR PUMPING

By Charles K. Fox and Charles M. Stokes

To find the theoretical horse-power required, follow vertically from the number of cubic feet per second to the curve for head in feet, thence horizontally to the left edge of the diagram for the horse-power. Using the right-hand side of the diagram, from the given theoretical horse-power at the left, follow the upward curve to the given efficiency and read the actual horse-power required at the right of the diagram. For computing the horse-power delivered for a given efficiency, read the downward curves.

For ordinary irrigation service, a centrifugal pump in good condition will develop from 30 to 55% efficiency, the efficiency increasing with the size of the pump. Plunger-pumps develop from 35 to 60% efficiency, the efficiency increasing with the size of the pump and the head. Air-lift pumps seldom give more than 20% efficiency. For large centrifugal pumps, the efficiencies obtained are considerably higher, reaching in some cases 75% for pumps having a capacity of 10,000 gallons or more per minute. Even for pumps of this size, the most favorable conditions are necessary in order to obtain these efficiencies. For wells where the lift is so great as to require a plunger-pump, sand-troubles frequently reduce the efficiency materially and make frequent pulling of the rods necessary. For this reason, the air-lift is often the most efficient pump.

Deep-well centrifugal pumps give a lower efficiency than ordinary pumps of this type because of friction losses at each successive lift. On the other hand, there is less difficulty from sand with a deep-well centrifugal than with a plunger-pump.

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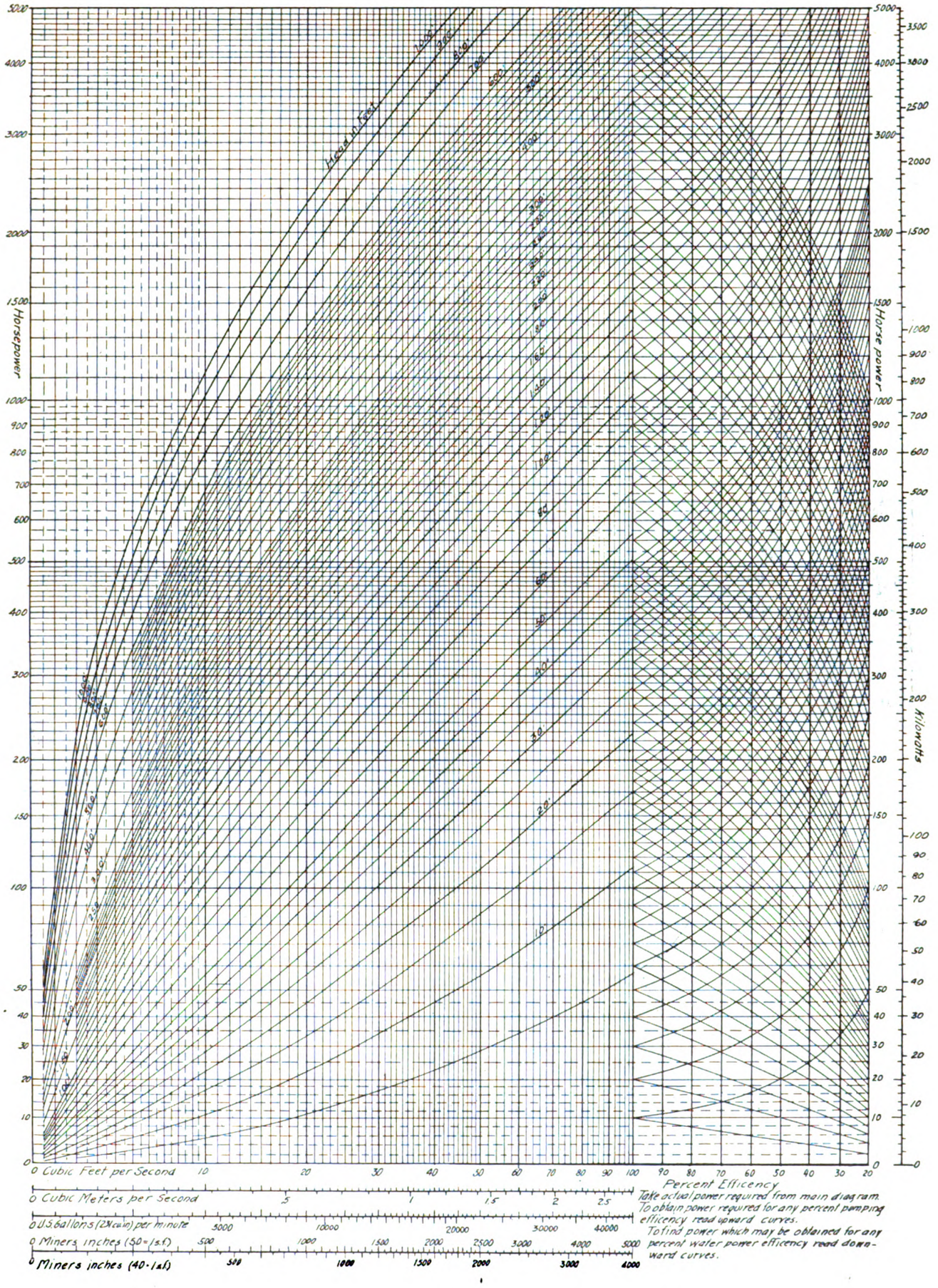

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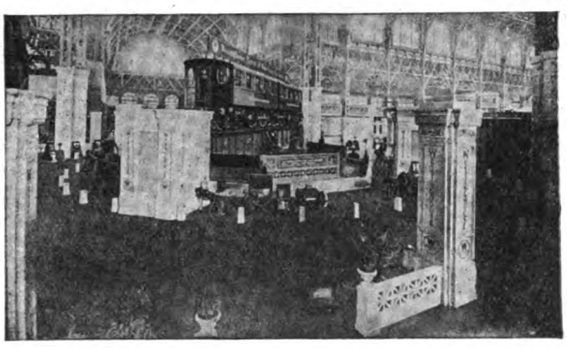
Industrial Progress

WESTINGHOUSE EXHIBIT AT THE EXPOSITION

A large and attractive exhibit has been arranged in the Palace of Transportation at the Panama-Pacific Exposition by the Westinghouse Electric & Mfg. Co., of East Pittsburg, Pa. It includes one of the Pennsylvania railroad electric locomotives mounted on a turn-table under the centre of the dome of the building at the junction of the two main aisles, thus bringing it in full view of visitors. The turntable is 65 ft. long, and weighs 440,000 lb., including the locomotive. The height of the track is 12 ft. above the floor. Steel ties are used, a new type of construction for this class of work. The foundation was described in the March issue of WESTERN ENGINEERING. By means of 10-hp., 3-phase, 220-volt motor, the turn-table revolves once in three minutes. The direction of rotation can be reversed. An unusual method of collecting the current for lighting the locomotive is employed. This was designed by the Westinghouse engineers and involves bringing the leads up through the centre bearing to collector rings, thus obviating the use of third-rail shoes or trolleys. The locomotive is arranged and lighted so as to permit the people to pass through it and inspect the equipment. This locomotive is said to be the largest in the world in passenger service. It consists of



WESTINGHOUSE ELECTRIC LOCOMOTIVE.

two units and weighs 156 tons, and is the first side-rod gearless locomotive ever placed in service. It is equipped with two motors having a total capacity of 4000 hp., and Westinghouse unit switch-control equipment of the HBF type which has made the great record of 99.549 miles per train minute. Statistics show that twelve million passengers are transported annually over the electrified terminal of the Pennsylvania railroad from Harrison, New Jersey, to Pennsylvania station, New York, by these locomotives, which are capable of attaining a speed of 60 miles per hour with full train.

In addition to the locomotive, the newly developed types PK and HL control for railway motors are shown in operation. These control equipments will operate motor-racks equipped with 40-hp. motors. The PK control operating head can be applied to any standard type K controller.

A complete line of commutating-pole railway motors, including box, and split frame types for various voltages from 600 to 1500 are also shown, and in addition a preliminary sample of the new pressed steel railway-motor.

In the Palace of Machinery the firm has an extensive exhibit. It includes the following: domestic motors, fans, and heaters; lamps and fixtures; transformers and motors open for inspection; single-phase motors; variable-speed alternating motors; induction motors; motors with forged-steel frame; back-geared induction motors for low driving speed, with rawhide pinion and steel spur wheel, now used largely in driving stamp-mills, etc.; enclosed direct-current motors; semi-enclosed direct-current motors; direct-current reversing motors for tool machines; vertical direct-current motors; direct-current elevator motors with semi-magnetic elevator controller; direct-current commutating-pole mill motors for the severest service; rheostats; Westinghouse Sirocco blower; Westinghouse Le Blanc low-level jet-condenser; and a Westinghouse-Parsons steam turbine (open for inspection) reaction type blading and impulse wheel direct-connected to a 652-kva. generator and 15-kw. direct-current exciter.

PIPES AT THE EXPOSITION

In the Palace of Mines and Metallurgy at the Exposition the U. S. Steel Corporation's exhibit covers a large area. Its subsidiary, the National Tube Co. of Pittsburg, has approximately 6000 sq. ft.

This company manufactures three closely related, and yet distinctly different, lines of products, and the exhibit naturally divides itself into the following sections, namely, (1) 'National' pipe and allied tubular products; (2) 'Kewanee' specialties,

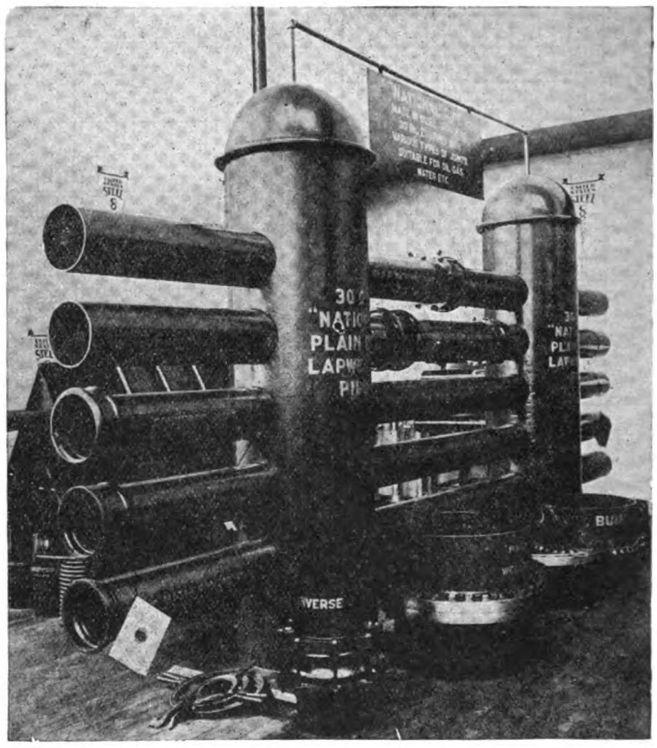


EXHIBIT OF LAP-WELDED PIPE.

fittings, etc.; (3) 'Shelby' seamless tubing and cylinders. The display of National pipe and allied products is the largest of the three sections. This is as it should be, inasmuch as National Tube Co. has an annual capacity exceeding 1,250,000 tons of tubular products.

Entering the main section, the visitor walks through a large arch, 15 ft. high, made of miscellaneous bends of 4-in. National pipe. Immediately behind this is a massive rack, on which are displayed the various types of National pipe used in the oil-fields of the world. Capping this rack, is the largest and longest individual length of lap-welded wrought pipe ever made in America, consisting of one length of 20-in. O.D. National pipe, 39 ft. 6 in. long. This double length of pipe, was welded at the National works of the company at McKeesport, Pennsylvania.

The right-hand portion of the main booth is devoted to the display of Kewanee specialties, including the Kewanee union, 'NTC' re-grinding valve, brass fittings, cocks and valves, malleable and cast iron and wrought fittings. Probably the

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most commanding feature of this section is the colossal model, made to exact proportions, of a two-inch octagon Kewanee union. An eighth section has been cut from one side of the model in order to show in cross-section the Kewanee patented principle, which consists of (a) brass to iron thread connection, no corrosion, (b) brass to iron ball-joint seat, no gasket, (c) 125 lb. compressed air test under water, no defective fittings, and (d) solid, three-piece construction, no inserted parts. Nearby is a working model of a testing machine, designed and used to give each Kewanee union a 125-lb. compressed air test under water, thereby protecting the consumer against the possibility of receiving defective unions. A complete line of Kewanee specialties and fittings is neatly displayed on a multiplex, swinging-leaf exhibit rack.

Across the aisle from the Kewanee section, in a separate booth, is the exhibit of Shelby seamless tubing and cylinders. Perhaps the most unique feature of this exhibit is a set of furniture, consisting of six chairs, one settee, and a table, made entirely of Shelby seamless tubing. The method of manufacturing seamless tubing from a square, flat plate, known as the 'cupping' process, is clearly explained in an exhibit which shows the various steps from flat to finished cylinders or tubes.

WOOD PIPES AND TANKS AT THE EXPOSITION

From the Redwood Manufacturers Co.'s plant at Pittsburg, Contra Costa county, California, have been displayed in the Machinery, Mines, California, and other buildings at the Exposition a lot of interesting products. In the first named is a 17,000-gal. capacity Remco tank connected with 12-in. machine-banded Remco pipe and a 80-hp. Bessemer engine and 12-in. Advance pump, 5000 gal. of water per minute being pumped through the 12-in. redwood stave-pipe at a velocity of 11 ft. per second; samples of Remco machine-banded pipe of standard make in various diameters from 2 to 24 in.; samples of Remco continuous-stave redwood pipe as erected in the field; samples of Remco machine-banded pipe wound with copper wire, furnished where acid or strong alkaline solutions are used; a section of 18-in. Remco continuous-stave pipe taken from the main flow-line of the city of Logan, Utah, in June 1914. This pipe-line, from which this piece was cut, was installed by the firm in 1892, and has been in continuous service for 23 years.

Outside of the Machinery building is the 50-ft. Remco tower, surmounted by a 30,000-gal. capacity Remco redwood tank, and supplied by 1500 ft. of 6-in. Remco machine-banded redwood stave-pipe. The pipe runs underground from San Francisco bay and salt water is pumped through it and into the tank, against a 75-ft. head. This exhibit supplies the water for the cooling system in the building.

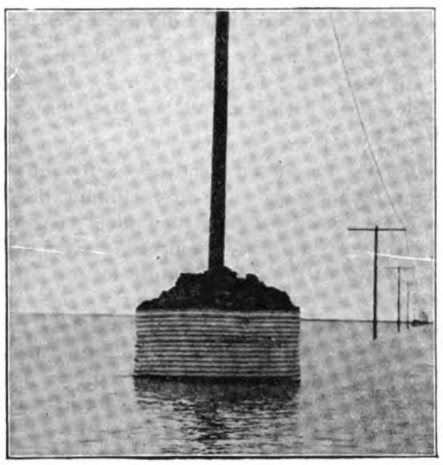
In the Mines building are three Remco redwood tanks and two towers exhibited by the firm in connection with the L. C. Trent Engineering Co. These tanks are in actual service, containing machinery and holding cyanide solutions.

Much of the sewer and drainage-pipe in the Exposition grounds is of the Remco brand. This is made either as continuous-stave or machine-banded. The former is made of redwood staves averaging 14 ft. long; the latter in sections 8 to 20 ft. long, and shipped ready to be laid.

Besides the pipe shown in the exhibits themselves, several of the lines in use for the various Exposition services are of redwood pipe. These include both temporary lines, which are to be taken up at the close of the Exposition-period, and permanent ones within the limits of the Presidio reservation.

CORRUGATED CULVERTS FOR PROTECTING TELEPHONE POLES

A telephone line recently constructed in Nevada crossed Humboldt lake. As the lake is shallow, the line was carried on poles in the usual way, but considerable difficulty was experienced at first from the rapid decay of the poles near the

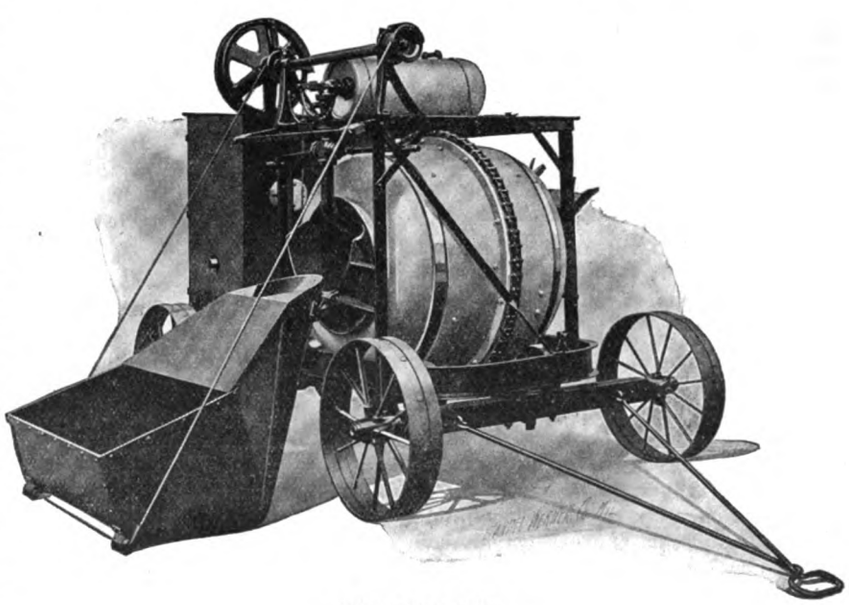


CULVERT PROTECTING BASE OF POLE.

water-line. Finally a section of corrugated culvert was placed around each pole and filled with stones as shown in the accompanying photograph, thus furnishing a reliable base for each pole. The results have been so satisfactory that the telephone company has decided to use a similar base for subsequent lines that cross shallow water, constructed in similar ground.

THE REX 'ONE-BAG' MIXER

There is a large demand on concrete work for a medium-sized mixer that can be sold at a moderate price. To meet this need, the Chain Belt Co., of Milwaukee, has recently put on the market a mixer having a capacity of ten cubic feet of unmixed materials, or for most mixtures one bag of cement. With the exception of the tongue and charging-platform, which are of wood, the mixer is entirely constructed of steel. The drum is of cast semi-steel, made in two sections and bolted in



VIEW OF MIXER.

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the middle. The mixing-blades are arranged so that the mixing operation is three-fold. The mixer is driven by a riveted chain-belt, and can be used with either a steam-engine, gasoline-engine, or electric-motor. It can be equipped if desired with a power-loader and an automatic water-tank.

Book Reviews

CONSERVATION OF WATER BY STORAGE. By George F. Swain. P. 369. Ill., index. Yale University Press, New Haven, Connecticut. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.

This volume is based on lectures delivered before the Sheffield Scientific School. The first chapter deals with the well-known but generally disregarded facts concerning waste and conservation of natural resources. After pointing out that while there is little or no absolute loss in allowing most natural resources to remain unused for a time, undeveloped water-power, on the other hand, is a total loss for the time being, the author discusses the laws relating to the use of water, particularly water for power-purposes. The doctrine of riparian rights and its modified application in many States is considered. The regulations of the Federal Government regarding water-power development at Government dams, at private dams, and on the public domain are discussed. The author holds that while the imposition of a tax on the private power-companies on the basis of power developed may be inadvisable, still such provisions have been but a slight hindrance to development as compared with the uncertainty of tenure for all projects dependent on the Federal Government for approval. The chapter on Technical Aspects of Conservation by Storage deals mainly with run-off data and with the construction of dams. Two chapters are devoted to Forests and Stream-Flow and to Floods and general means for their prevention or mitigation. The appendix contains several legal documents pertaining to the question of water-power development and a bibliography.

INTERNAL COMBUSTION ENGINES. By Robert L. Streeter. P. 409. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $4.

The first few chapters of this volume are mainly introductory and contain the usual information regarding the laws of gases, energy, the history of the internal-combustion engine, the Otto cycle, etc. Liquid and gaseous fuels are then discussed. The Otto and Diesel cycles are considered and compared. Considerable space is then devoted to ignition, carburetion, and governing. Power, efficiency, and the cost of power as generated by the different types of engines are then discussed. The different types of both oil and gas engines are described as well as the Humphrey gas-pump. The remainder of the book is devoted principally to engine-design.

VALVES AND VALVE-GEARS. Volume II. By Franklin DeRonde Furman. P. 437. Ill., index. John Wiley & Sons, Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.

The first volume of this work, dealing with valves for steam engines and steam turbines, was reviewed in WESTERN ENGINEERING for June 1915. The present volume continues the subject, discussing gasoline, gas, and oil engines. The treatment is the same as in Volume I, and amplification of notes for a college lecture-course, but both volumes will prove valuable to the engineer as well as to the student. The general theory of admission and exhaust for both two and four-cycle engines for different arrangements of cylinders is discussed, together with the various methods of ignition. The application of this theory to the design of valves for ordinary gasoline engines is then considered. A chapter is devoted to the special problems encountered in the design of aeroplane-engines. Valves for gas engines, ordinary oil engines, and diesel engines are considered in turn, and the book closes with a few remarks on the comparative efficiency of the various prime movers.

IRRIGATION PRACTICE AND ENGINEERING. By B. A. Etcheverry. Vol. I. Use of Irrigation Water and Irrigation Practice. P. 207. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.

This is the first of three volumes, the others dealing with conveyance of water and with irrigation structures. The present volume deals in general with subjects that are of more direct interest to the farmer than to the irrigation engineer, but which the latter should understand if he is to plan his own work to the best advantage. Methods of irrigation, the amount of water needed for various crops, and the duty of water are discussed and a large amount of experimental data given. The preparation of land for irrigation is considered, together with the distribution of irrigating water by ditches, flumes, pipes, etc. The concluding chapter is devoted to small pumping plants.

SURVEYING MANUAL. By William D. Pence and Milo S. Ketchum. P. 384. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.

This is the fourth edition of this useful manual. The book has been thoroughly revised and considerable new matter included. The general subject of surveying, the use of instruments, methods, etc., occupies most of the volume. Public-land surveying and the retracement of old lines is then discussed. The next chapter treats very briefly of railroad surveying, circular railroad curves being merely mentioned and spirals not even that. It is evident, however, that the authors expected some other text-book to be used for this branch of the work. Other chapters treat of probable error, methods of computing, and topographic drawing. The usual mathematical tables are included. This edition, as well as those that have preceded it, will be of great value as a student's text-book, and to some engineers as a reference pocket-book as well.

New Publications

NATIONAL BULLETIN No. 20. The National Tube Co., Pittsburgh, Pennsylvania. P. 32. Ill. This is a well-arranged index of the various Bulletins issued by the company beginning with No. 1.

METHODS OF CONSTRUCTION OF LARGE-CAPACITY DEEP WELLS. Bulletin No. 141. The American Well Works, Aurora, Illinois. Describes the rotary outfits manufactured by the company for drilling water-wells of this kind.

ROAD CONSTRUCTION AND MAINTENANCE. E. I. du Pont de Nemours Powder Co., Wilmington, Delaware. P. 120. Ill. Among the many 'trade publications' dealing with road construction that have been issued during the past few years, this is probably the most valuable. As would naturally be expected, the use of explosives in road-building is given considerable attention, many practical hints being given regarding kinds of powder and methods of blasting to be used to meet given conditions, as well as suggestions for new uses for explosives, such as the preparation of a surface-ditch by the simultaneous firing of a series of shallow holes. The book also deals with the general question of road-improvement and would be of value to anyone having to do with such work. Copies may be obtained upon application to the company.

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Construction News Summary

PRESENT STATUS OF ENGINEERING PROJECTS ON THE PACIFIC COAST

(Engineers and others connected with construction work are invited to make use of these columns to acquaint other members of the profession and the general public with the progress of work under their charge.)

PROJECTS OF UNITED STATES RECLAMATION SERVICE

MINIDOKA PROJECT, IDAHO—Second unit has been installed at Boersch Lake pumping-station, and both units put into regular operation. Floating dredge has completed excavation of D-14 drain and has been moved to main drain near Rupert. Contracts have been let for several laterals on South Side canal. Dana Templin, Rupert, Idaho, is engineer.

MILK RIVER PROJECT, MONTANA—Earthwork and structures on Nelson reservoir have been completed. Work on Nelson Reservoir south canal is under way, as well as Bowdoin main canal. Work now under way includes 700,000 cu. yd. earth excavation, and 2200 cu. yd. concrete. W. W. Schlecht is project manager.

ARROWROCK DAM, IDAHO—Arrowrock dam is completed. Dam is 1100 ft. long on top, with a maximum height of 348.5 ft., and contains 585,200 cubic yards. Storage-capacity of the reservoir is 244,300 acre-feet. C. H. Paul is construction engineer.

SALT RIVER PROJECT, ARIZONA—Sixth unit is being installed at Roosevelt power-plant.

YUMA PROJECT, ARIZONA-CALIFORNIA—About 30,000 cu. yd. of rock was placed for river-front protection at various points. In Yuma valley 7000 cu. yd. of material was moved in raising canal-banks and extending small canals.

GRAND VALLEY PROJECT, COLORADO—On main canal, 14,000 cu. yd. earth was moved by Winston Bros. Co., 30,000 cu. yd. by Reynolds-Ely Construction Co., and 37,000 cu. yd. by Mendenhall, Straw & Bird Co. In first lateral district, 40,000 cu. yd. was moved. Government forces constructed several small culverts and other structures. Progress was made on Grand River diversion dam.

HUNTLEY PROJECT, MONTANA—In construction of open drains, 32,600 cu. yd. of earth was moved. On the closed drains, 8090 lin. ft. was excavated and tile laid, and 2100 lin. ft. of flume constructed for the outlet to drain No. 10.

ELEPHANT BUTTE DAM, NEW MEXICO—On the main dam, 7000 cu. yd. of concrete was placed, making a total of 555,300 cu. yd. For the spillway, 1100 cu. yd. was placed, making a total of 1190 cubic yards.

GENERAL CONSTRUCTION IN WASHINGTON

HIGHWAY WORK—Since 1911, 528 miles of permanent highways have been constructed by the various counties of the State and 125 miles is now under construction. The length of the different types of surfacing is as follows: brick, 23 miles; concrete, 67; sheet asphalt, 4; warrenite, 6; bituminous macadam, 10; asphaltic macadam, 36; oil-bound macadam, 16; rolled gravel, 97; spread gravel, 142. Four miles of highway from Kalama southerly has recently been completed by Porter & Conley, of Portland, Oregon, and four miles of highway from Steptoe to Cashup has been completed by the General Construction Co. of Spokane. Spokane, Portland & Seattle railroad has commenced construction of line northerly from Klickitat, a distance of 12 miles.

GENERAL CONSTRUCTION IN CALIFORNIA

GOVERNMENT WORK ON SACRAMENTO RIVER—Two suction dredges working between Rio Vista and Collinsville removed 569,855 cu. yd. of material during August.

STATE HARBOR WORK AT SAN FRANCISCO—Pier No. 24 is finished. Work has been commenced on pier 22 by Tibbetts-Pacific Co. Pier 35 will be completed early in October. Plans are being prepared for paving along water-front from Ferry building to pier No. 18 and for a number of small concrete buildings near the Ferry building. Bids will be received until October 7 for construction of Pier No. 29.

HETCH-HETCHY VALLEY—Work has been started on diversion tunnel, 10 ft. in diameter, to serve as by-pass for waters of Tuolumne river during construction of main dam. Plans have been completed for railroad from Rosasco on Sierra railroad to the dam-site, 67 miles long, and negotiations are now under way with several contracting firms to build the road and take payment in municipal bonds.

SAN FRANCISCO MUNICIPAL WORK—Mile Rock tunnel completed. Work is progressing from both ends of Twin Peaks tunnel, and from Laguna Honda station. Work is in progress on Twin Peaks boulevard. Golden Gate boulevard from Lincoln Park to Presidio has been completed. Central fire-alarm station at Jefferson square has been formally opened.

Grading on State highway between Yreka and Hornbrook has been completed, and it is expected that bridge-work will be finished before winter. Branch of Northern Electric railroad between Colusa and Meridian which was washed out will be opened for traffic on October 15. In Sacramento, $338,100 worth of street work has been completed since January 1 or is now under way. Sewers costing $586,000 and water-mains costing $713,000 are being laid. At Richmond, municipal highway to wharf is practically completed. Filling for wharf is under way, and pouring of concrete piles is nearly completed. In Stockton, street-work costing $300,000 is under way. Contract for first unit of storm-sewer will be awarded early in October. In Kings county, contract for construction of first section of county highway system has been awarded, also contracts for furnishing cement, asphalt, rock, and other materials have been awarded. Grading on State highway between Bakersfield and Los Angeles has been completed and road will be open to travel early in October. In Orange county, contracts for 130 miles of road have been awarded, 119 miles has been graded, concrete has been laid on 107 miles, and 114 miles has been completed, the specifications not calling for concrete on all roads.

General Summary

Condensed From Our Daily Construction News Service.

CALIFORNIA

ALAMEDA—Contract for placing asphaltic surfacing over old macadam pavement on Santa Clara avenue has been awarded to Ransome-Crummey Co., First Savings Bank Bdg., Oakland, for 1½c. per square foot.——City council has appropriated $50,000 from regular tax-levy for permanent street improvements.

ARBUCKLE—Following contracts have been awarded for levee work in district No. 479; along Baldson lands, to A. Kalfsbeck, for $4502, and from Sycamore slough to Hannum bridge, to W. T. Wilkins & Son, for $8040. This firm also has a contract for work costing $4500 in district 108.

ARCADIA—Contract for about 20 miles of trenching for water-system has been awarded to R. F. Ware, Marsh-Strong Bdg., Los Angeles, for 5c. per lin. ft. for all trenches, regardless of size. Trenches range from 18 to 30 in. wide.

BAKERSFIELD—Contract for construction of 9¾ miles of county highway on Mojave road has been awarded to Castro & Blaisdell for $100,467.34. Contract for construction of 5⅛ miles of Glennville road has been awarded to Shattuck & Nimmo Warehouse Co. for $25,041.90. Contract for construction of 6¼ miles of Edison road has been awarded to L. G. Garnsey, 514 Central Bdg., Los Angeles, for $28,858.58.——Bids will be received until 11 a.m., October 7, by I. L. Miller, county clerk, for grading and construction of bridges, culverts, and concrete pavement on road between Kern River bridge and Rosedale. Plans from county highway commission upon payment of $5, not returnable.——Election has been called for October 14 to vote on bond issue of $150,000 for system of parks. Daniel Harris is park commissioner.——George W. Jones, assistant engineer for Los Angeles county highway department estimates cost of building road to summit of Mount Whitney at $303,000. C. A. Barlow is interested.——Contract for improvement of two blocks on O street has been awarded to L. S. Stroud for 3⅛c. per sq. ft. for grading and oiling, 34c. per lin. ft. for curbs, and 16c. per sq. ft. for gutters, a total of $1543.08.——Contract for repair of tunnel No. 15 near Marcel on Southern Pacific railroad has been awarded to Robert Sherer & Co., Pacific Electric Bdg., Los Angeles. Tunnel was closed last spring on account of a fire and cave-in, and will be re-driven and lined with concrete.

BERKELEY—Compromise between city officials and San

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Francisco-Oakland Terminal railway has been effected, and the company will spend $35,000 on permanent ballasting and drainage on Grove street and on Allston way, and permanent pavement on Adeline street.

BURLINGAME—Contract for construction of ten concrete bridges has been awarded to Chris Larsen, Easton, for $20,575.

COMPTON—Contract for improving several streets has been awarded to E. A. Clayton, 1321 Vanderbilt street, Bairdstown, at 15 to 20c. per lin. ft. for grading, 2¾c. per sq. ft. for oiling and tamping, 27c. per lin. ft. for concrete curb, 10½c. per sq. ft. for cement sidewalk, and 14c. per sq. ft. for concrete gutter.

DIXON—Supervisors of Yolo and Solano counties have decided to proceed with construction of bridge over Putah creek on State highway. Estimated cost is $30,500.

DUNSMUIR—Construction of sewer system has been proposed.

ESCALON—Formation of lighting district has been ratified at election.

EUREKA—Contract for construction of trestle bridge on Ferndale road has been awarded to Mercer-Fraser Co. for $2523. ——Contract for construction of reinforced concrete bridge over Strong's creek has been awarded to John Brissey, Fortuna, for $1850. Contract for construction of bridge over Little Van Duzen river has been awarded to Moore & Lentell for $3475. Contract for repairing Mosley Slough bridge has been awarded to W. F. Greenlaw for $795.

FRESNO—Bids will be received until 9 p.m., October 4, by W. H. Ryan, city clerk, for furnishing 3000 lin. ft. of 2½-in. fire-hose and 1000 lin. ft. of 1½-in. fire-hose.

GIANT—Atlas Powder Co. will make additions to plant. Contract for grading has been awarded to Bates, Borland & Ayer, Oakland Bank of Savings, Oakland.

GRASS VALLEY—Trustees have decided to widen Main street. Estimated cost is $1200.——Carnegie library, costing $15,000, will be constructed. William Mooser, Nevada Bank Bdg., San Francisco, is architect.

HANFORD—Contract for furnishing crushed rock for county highways has been awarded to Grant Rock & Gravel Co., unit prices f.o.b., Roche, being as follows: 175,000 tons 1½ to 2¼-in. rock, 52½c. per ton; 75,000 tons ¼ to 1½-in. rock, 58c. per ton; 37,500 tons, ⅜ to ¾-in. rock, 60c. per ton; screenings, 27c. per ton.——Contract for construction of 2¾ miles of county highway has been awarded to Thompson Bros., Fresno, at the following unit prices: 3587 cu. yd. excavation at 50c., 14,442.5 lin. ft. shaping roadbed at 10c., 7440 tons broken stone, sand, or screenings, in asphalt macadam pavement at $1.08; 60 cu. yd. class A concrete at $15, 11.34 cu. yd. class B concrete, at $14, 3267 lb. steel at 6c.——Contract for furnishing 4800 tons of 'E' grade asphaltum has been awarded to Standard Oil Co. for $4.35 per ton f.o.b. Bakersfield.

HAYWARD—City council has decided to macadamize several streets.

HOLLISTER—Contract for grading, graveling, and construction of bank protection on five miles of road from Tres Pinos to Paicines has been awarded to Lou G. Hare, Salinas. Estimated cost is about $15,000.——Contract for paving Monterey street has been awarded to Ransome-Crummey Co., First Savings Bank Bdg., Oakland, for 13c. per sq. ft. for pavement, and 35c. per sq. ft. for curbs and gutters.

KENNETT—Bonds for $5000 to pay for city's share of cost of bridge across Sacramento river have been voted. Contract has already been awarded to Portland Bridge Co., Portland, Oregon.

LINDSAY—City trustees have passed resolution of intention to construct 55,000 sq. ft. of 2-in. asphaltic concrete pavement on macadam base on Hermosa avenue. H. D. Watts, Exeter, is city engineer.

LOS ANGELES—Contract for construction of subway under Santa Fe tracks at Avenue 46 has been awarded to Mercereau Bridge & Construction Co., Pacific Electric Bdg., for $1787.——Traffic engineer Howell has prepared plans for viaduct over Pacific Electric railroad tracks connecting West boulevard and Sherman drive. Estimated cost is $40,000. Also plans for viaduct at First street over railroads, river, and industrial district.——City engineer Homer Hamlin has submitted plans for grading Bunker hill. One plan calls for tunnel 2000 ft. long, and estimated cost is $940,000. A second plan calls for an open-cut, involving about 1,000,000 cu. yd. excavation, and the estimated cost is $1,284,000. The third plan is for a more extensive open-cut costing $2,000,000. These estimates are exclusive of land-damages.——Contract for improvement of alley near Arapahoe street has been awarded to Southern California Contracting Co., Washington Bdg., for 1c. per sq. ft. for grading, and 10.58c. per sq. ft. for concrete pavement, a total of $937.98. ——Contract for improvement of alley near Vermont avenue has been awarded to William Liddington, 420 East 60th street, for 2c. per sq. ft. for grading and 11c. per sq. ft. for concrete pavement, a total of $1192.10.——Contract for construction of Garvey school has been awarded to B. H. Paul, 2018 West 28th street, for $23,570.——Contract for construction of South Park school has been awarded to F. O. Engstrum Co., 5th and Seaton streets, for $31,377.——Contract for improving Pacific avenue has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., at 4c. per sq. ft. for grading, 16.9c. per sq. ft for bitulithic pavement, 35c. per lin. ft. for curbs, 45c. per sq. ft. for granite block gutter, $13,000 for storm drain, and $13,000 for sanitary sewer, a total of $92,096.01. California-Arizona Construction bid $94,157.75.——Contract for improving Yale street has been awarded to Coast Construction Co., at 1.3c. per sq. ft. for grading, 11c. per sq. ft for asphalt pavement, 30c. per lin. ft. for curbs, 10c. per sq. ft. for sidewalks, 35c. per sq. ft. for granite block gutter, a total of $3648.29. Other bidders were George R. Curtis, $4350; California-Arizona Construction Co., $5416.20; Fairchild-Gilmore-Wilton Co., $4869.72.——Contract for improving Sierra Bonita has been awarded to J. J. Papac, 726 North Hill street, at 1½c. per sq. ft. for grading, 12⅞c. per sq. ft. for concrete pavement, 35c. per lin ft. for concrete curb, and $420 for sanitary sewer, a total of $1980.75. Other bidders were Coast Construction Co., $2006.74, and J. I. Radowich, $2145.91. ——Contract for construction of Annandale school has been awarded to G. W. Gilbreth & Co., 416 Hollingsworth Bdg., for $26,067.——Contract for construction of brick grammar school at San Pedro has been awarded to Cresmer Manufacturing Co., Riverside, for $79,740.——Contract for improving 3rd street has been awarded to Tryon & Brain, 501 Merchants Trust Bdg., at 1.7c. per sq. ft. for grading, 14.9c. per sq. ft. for asphalt pavement, 28c. per sq. ft. for vitrified brick pavement, 30c. per lin. ft. for curbs, 10c. per sq. ft. for sidewalks, 18c. per sq. ft. for concrete gutters, 40c. per sq. ft. for granite block gutters, a total of $72,174.87.——Contract for improving Mariposa avenue has been awarded to H. C. Withers, Builders Exchange, for $11,743.66.——Contract for improving Evergreen avenue has been awarded to G. T. McLain, 4834 Fountain avenue, for $1616.63.——Weymouth Crowell, 2026 West 9th street, has been awarded contract for construction of 8-story reinforced concrete building at 6th and Los Angeles streets, for William Kerchoff.——Contract for construction of South Park school has been awarded to F. O. Engstrum Co., 5th and Seaton streets, for $31,377.——Contract for furnishing about 40,000 bbl. of cement for municipal warehouse, dock No. 1, has been awarded to California-Portland Cement Co., American Bank Bdg., for $2.15 per barrel.——Contract for improving McKinley avenue has been awarded to W. A. Farish & Co., 353 South Hill street at 1c. per sq. ft. for grading, 16c. per sq. ft. for asphalt pavement, 8.5c. per sq. ft. for oiled macadam pavement, 30c. per lin. ft. for curbs, 9.7c. per sq. ft. for sidewalks, 12.5c. per sq. ft. for concrete gutter, 35c. per sq. ft. for granite block gutter, a total of $24,820.78.——Contract for construction of road-improvements in Lamanda Park has been awarded to E. A. Baker, H. W. Hellman Bdg., for $4364.20.——Contract for improving Alpine street has been awarded to Coast Construction Co., 353 South Hill street, at 1c. per sq. ft. for grading, 11c. per sq. ft. for asphalt pavement, 29c. per sq. ft. for vitrified brick pavement, 30c. per lin. ft. for curb, 10c. per sq. ft. for sidewalks, 30c. per sq. ft. for vitrified block gutter, 35c. per sq. ft. for granite block gutter, a total of $4081.39. Other bidders were George R. Curtis, $4405.14; Fairchild-Gilmore-Wilton Co., $4616.50; California-Arizona Construction Co., $4762.63; H. C. Withers, $4774.62.——Contract for construction of 880-ft. plate-girder bridge across San Gabriel river near El Monte has been awarded to Mesmer & Rice, 220 Marsh-Strong Bdg., for $93,000. Bridge will have concrete piers and reinforced concrete floor and abutments.——Contract for improvement of alley near 21st street has been awarded to J. R. Radonich, 1226 Sunset boulevard, for 1c. per sq. ft. for grading, 11c. per sq. ft. for concrete pavement, and 14c. per sq. ft. for concrete gutter, a total of $1082.——Contract for improvement of 54th street has been awarded to California-Arizona Construction Co., 1700 East Washington street, for 1.5c. per sq. ft. for grading and 12.4c. per sq. ft. for asphalt paving.

MADERA—Bonds for $12,000 for construction of concrete bridge over Fresno river at D street have been voted.

MANHATTAN BEACH—Contract for improving 18th, 19th, and 20th streets has been awarded to Crown Contracting Co. for $21,061.69.

MARTINEZ—Contract for building link of Lafayette road has been awarded to P. H. Hoare, Bacon Bdg., Oakland, for $35,000.——C. A. Leighton is making surveys and preparing plans for Mount Diablo boulevard. Road will be built as a district improvement. Bond election will probably be called soon.

MARYSVILLE—Contract for extending storm sewer a distance of 2100 ft. has been awarded to Stanley & Ostander, Sacramento, for $13,550.——Contract for filling in same district has been awarded to Hewitt & Felch for 43c. per cu. yd. or a total of $14,710.

MERCED—County surveyor A. E. Cowell is preparing plans for concrete bridge over Santa Rita slough on road from Dos Palos to Los Banos.

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MODESTO—Plans are being prepared by F. C. Herrmann, chief engineer, Modesto irrigation district, Merchants Exchange Bdg., San Francisco, for cement facing of dam No. 6 of Dallas reservoir, and calls for bids will be issued soon.——Contract for construction of nine small concrete bridges has been awarded to Barrett & Hilp, Sharon Bdg., San Francisco, for $14,525.

NEVADA CITY—Contract for construction of cement sidewalks has been awarded to W. H. Bolton for 10c. per square foot.

OAKLAND—Contract for erection of reinforced concrete lighting-posts on Telegraph avenue has been awarded to F. L. Carson for $42 each. Posts are to have a concrete foundation two feet square and two feet high, and a reinforced concrete standard 10 ft. 4 in. high, with one tungsten light enclosed in a glass globe.——Contract for improving Deering street has been awarded to Kopperud Construction Co. at 25c. per cu. yd. for excavation, 30c. per lin. ft. for concrete curbs, 12c. per sq. ft. for concrete gutter, 9c. per sq. ft. for oil macadam pavement, and 10c. per sq. ft. for cement sidewalk.——Contract for laying sewers on several streets has been awarded to Schuyler & Edwards at 74c. per lin. ft. for furnishing and laying 8-in. vitrified pipe, $50 each for brick manholes, and $10 each for lampholes.——Contract for improving 61st street has been awarded to Oakland Paving Co., First Savings Bank Bdg., at 12c. per sq. ft. for oil macadam, 14c. per lin. ft. for redwood curbs, and 17c. per sq. ft. for concrete gutters.——Contract for construction of addition to courthouse has been awarded to L. H. Stock, 12 Geary street, San Francisco, for $15,299. ——Contract for construction of municipal belt-line railroad has been awarded to Blake Bros. Co., Oakland Bank of Savings Bdg.——Bids will be received until 9 p.m., October 5, by Charles S. Greene, secretary board of library directors, for construction of Melrose branch library. Plans from W. H. Weeks, 75 Post Street, San Francisco, upon deposit of $20.——Consulting engineer M. K. Miller has prepared plans for reclaiming 87 acres of marsh land in West Oakland. Estimated cost is $50,000.——Contract for construction of bridge near Alvarado has been awarded to C. A. Bruce, Pleasanton, for $1450.73. Contract for construction of two other bridges in that vicinity has been awarded to T. B. Russell, Hayward, for $2202.43.

OROVILLE—Contract for construction of hall of records has been awarded to Western Building & Engineering Co., San Francisco, for $43,843.——Contract for construction of eight small concrete bridges on State highway has been awarded to Chico Construction Co., Chico, for $12,987.——Contract for construction of bridge across Durham slough has been awarded to same company for $1190.——Contract for bridge over north channel of Butte creek has been awarded to O. A. Peters for $2713.——Formation of irrigation district in vicinity of Thermalito has been proposed. District will contain about 2000 acres. L. Van der Naillen, manager of Oro Electric Corporation, is interested.——Supervisor Evans has been authorized to proceed with the construction of 14 small bridges in his district. Supervisor Whipple has been authorized to repair bridge at Rackerby.——Drainage district No. 100 has been organized containing about 18,000 acres. George F. Jones is interested. ——Western Canal Co. will soon ask for bids for construction of second unit of canal from Dry creek to Butte creek. Great Western Power Co., 14 Sansome street, San Francisco, is interested.——Third unit of Western canal will probably be built this fall. Washington Dodge, 2129 Laguna street, San Francisco, is interested. Canal will be five miles long and will extend from Butte creek westerly.——Board of supervisors has voted to pave additional 20-ft. strip on State highway through town of Durham.——Hydraulic miners are proposing construction of dam 72 ft. high on Feather river, about a mile above town, so as to permit hydraulic mining on Feather river and its tributaries. H. R. Berkey, of Sierra county, is interested. Estimated cost is $1,000,000.

PARADISE—Petition will be presented to board of supervisors this month for formation of irrigation district, including about 15,000 acres.

PASADENA—Bids will be received until October 19 by H. Dyer, city clerk, for the following work: changing old cluster lights in down-town district to Novalux unit on 111 posts and setting and equipping 36 more cast iron posts; construction of ornamental lighting system on West Colorado street, including 34 copper-jacketed lamp-posts, and a 1-in. sheradized conduit; construction of 2180 lin. ft. of 8-in. vitrified pipe sewer, with seven man-holes and two flush-tanks. R. V. Orbison is city engineer.

PLACERVILLE—Construction of new road from Chili Bar bridge to Kelsey has been proposed. Road will be 4½ miles long and will cost $20,000. C. H. Wildman is county surveyor. ——Bids will be received until 1 p.m., October 4, by C. H. Weatherwax, city clerk, for furnishing 100 ft. of rubber-lined cotton fire-hose.

PORTERSVILLE—Contract for construction of pavement around high-school grounds has been awarded to Federal Construction Co., Sharon Bdg., San Francisco, for 15c. per sq. ft. for 5-in. concrete base and 1½-in. topeka top, 40c. per lin. ft. for curbs, and 15c. per sq. ft. for sidewalks.——Contract for paving several streets with 5-in. concrete base and 1½-in. topeka wearing surface has been awarded to Federal Construction Co., Sharon Bdg., San Francisco, for $50,000.——Portersville Magnesite Co. has been organized to develop deposits near city. C. S. Woody and H. L. Doyle are interested.

RED BLUFF—Contract for construction of three concrete bridges on State highway has been awarded to Ross Construction Co., Sacramento, for $17,000.——Contract for construction of steel bridge across Molinos river has been awarded to C. E. McCartney for $1293.

REDDING—Contract for construction of concrete bridge over Clear creek has been awarded to William Stephens for $6166. ——Contract for construction of steel bridge over Sacramento river at Kennett has been awarded to Portland Bridge Co., Yeon Bdg., Portland, Oregon, for $15,976. City of Kennett will furnish steel costing $1750, making the total cost of the bridge $17,726.

REDONDO BEACH—Contract for construction of South grammar school has been awarded to William Bell for $24,579.

RIVERSIDE—Contract for construction of 9.29 miles of concrete road on route No. 11 has been awarded to C. L. Hyde Construction Co., Spreckels Bdg., San Diego, for $38,740.70.——Contract for construction of 3.57 miles of concrete pavement on routes 13 and 14 has been awarded to Brashear-Burns Co., Van Nuys Bdg., Los Angeles, at 20c. per cu. yd. for grading, 7c. per lin. ft. shaping roadbed, $10 per cu. yd. for concrete in structures, $1.89 per cu. yd. for concrete in pavement, 4c. per lb. for reinforcing steel, and 50c. per lin. ft. for guard fence, a total of $10,998.90. Other bidders were Moughmer & Rupp, $11,409.23; Conner Contracting Co., $13,046.11; Oscar Ford, $13,104.92; Doran & Armstrong, $13,629.50; Mesmer & Rice, $15,269.61; Rogers Bros. Co., $15,535.96; C. L. Hyde Construction Co., $16,885.05.——Contract for construction of 8.71 miles of concrete road on route No. 2 and part of route No. 1 has been awarded to Isbell Construction Co., 3969 Oregon street, San Diego, at 30c. per cu. yd. for excavation, 6½c. per lin. ft. for shaping roadbed, $10 per cu. yd. for concrete in structures, $1.56 per cu. yd. for concrete in pavement, $1 per lin. ft. for 16-in. vitrified pipe, 50c. per lin. ft. for guard fence, a total of $22,740.78. Other bidders were G. R. Daley, $24,988.44; Conner Construction Co., $26,271.10; Brashear-Burns Co., $27,991.09; Doran & Armstrong, $30,201.66; C. L. Hyde Construction Co., $30,898.88; Rogers Bros. Co., $31,024.30; Mesmer & Rice, $32,430.82.——Contract for improvement of 2.58 miles of route No. 16 has been awarded to Moughmer & Rupp, 440 West 9th Street, Long Beach, at the following unit prices: 2070 cu. yd. excavation at 30c.; 13,638 lin. ft. shaping roadbed at 8c.; 5 cu. yd. concrete in structures at $10; 2690 cu. yd. concrete in pavement at $1.80; 300 lb. reinforcing steel at 5c., a total of $6366.53. Other bidders were J. M. Montgomery Construction Co. at $6741.29, and Conner Contracting Co. at $7929.80.——Board of supervisors has appropriated $12,000 for construction of bridge over Santa Ana river near Corona.

SACRAMENTO—Contract for improvement of part of Front street has been awarded to McGillivray Construction Co.——Contract for improvement of another part of Front street has been awarded to A. Teichert & Son.——Contract for improvement of several alleys has been awarded to McGillivray Construction Co.——Following bids have been received by state highway commission for construction of 532-ft. reinforced concrete bridge over Sacramento river near Dunsmuir: F. H. Green, Eureka, who was awarded the contract, $22,600; P. J. Lechner, 2515 San Jose Avenue, Alameda, $23,994; Moffet & Mead, Monadnock Bdg., San Francisco, $24,750; Pacific Coast Construction Co., Fresno, $27,300. Engineer's estimate, $27,834.38.——R. A. Herold is preparing plans for county hospital. Estimated cost is $400,000.——Committee appointed by Good Roads Association has reported in favor of construction of 148 miles of permanent highway. Lynn C. Simpson is chairman of committee.——State department of engineering will build John Muir trail by day labor.

SALINAS—Board of supervisors is considering plans for jetty protection work at King City. F. E. Sullivan, of Spreckels Sugar Co., is interested.

SAN BERNARDINO—Pacific Electric railway will build reinforced-concrete freight-depot. Estimated cost is $25,000.

SAN DIEGO—City council has adopted general plan for waterfront and tide-land improvements including construction of boulevard and extension of belt-line railway.——Contract for construction of buildings for naval radio-station has been awarded to Jacobs Construction Co., 518 H. W. Hellman Bdg., Los Angeles, for $39,950.——City engineer George Cromwell is preparing plans for sewer on Atlantic street.——Harbormaster Lew B. Harris is preparing plans for wharf at foot of F

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street for use of fishermen.——City engineer George Cromwell has prepared plans for lighting system on lower Broadway. Estimated cost is $4839.——Contract for erection of steel bridge at end of tunnel No. 4, on San Diego & Arizona railroad has been awarded to C. W. Corbalet Co., I. W. Hellman Bdg., Los Angeles. Contract for furnishing steel has been awarded to Llewellyn Iron Works, Los Angeles.

SAN FRANCISCO—Park commissioners have decided against extension of the Geary Street municipal railroad through Golden Gate Park.——Contract for construction of Islais Creek sewer has been awarded to F. Rolandi, 550 Montgomery street, for $29,554.——Contract for paving Arguello boulevard and for paving Fulton street has been awarded to Owen McHugh, Russ Bdg., for $4428 and $11,188, respectively.——Contract for grading 37th avenue has been awarded to Blanchard-Brown Co., 660 Market street, for $5931.——Contract for erection of steel frame for public library building at Civic Center has been awarded to California Construction Co., New Call Bdg., for $17,175. Contract for furnishing structural steel has been awarded to Pacific Rolling Mill Co., 17th and Mississippi streets, for $85,433.——Bids will be received until 10 a.m., October 4, at U. S. Engineer Office, 405 Custom House, for the purchase of 7000 lb. of old rubber, 2400 lb. scrap iron, 4000 lb. of old manila rope, 9000 lb. wire rope, 450 lb. old canvas.

SAN JOSE—County surveyor I. L. Ryder has been authorized to purchase cement-testing apparatus.——County surveyor has been authorized to prepare plans for reinforced concrete bridge over Campbell creek on Prospect road.——Peninsular Electric railroad will construct standard-gauge railroad from eastern city limits to Kirk avenue.——Contract for construction of drain on Tully road has been awarded to W. S. Gause, Oakland, for $2244.——Contract for construction of Noble Avenue bridge has been awarded to Sam Sciarrino for $1912.——Contract for improvement of Canoas Creek by-pass has been awarded to M. E. Kilcourse for $10,230.——Contract for construction of reinforced concrete bridge on Bodfish road has been awarded to William Radke for $1985.——All bids for construction of reinforced concrete bridge on Malone road have been rejected.——Contract for construction of four wooden bridges on Silver Creek road has been awarded to R. H. Pearce for $693.——Contract for furnishing crushed rock on Glen Ridge has been awarded to George H. Yocco, Los Gatos, for $1.095 per cu. yd. Contract for furnishing crushed rock in district No. 4 has been awarded to George H. Yocco for $1.415 per cu. yd.——Contract for construction of reinforced concrete bridge on Shannon road has been awarded to S. Sciarrino for $1029.——Contract for furnishing crushed rock in district No. 5 has been awarded to J. F. Adams for $1.30 per cu. yd.——Contract for improving Oakland road through town of Milpitas has been awarded to Albert Klatt for $1996.40.——Contract for construction of reinforced concrete bridge on Malone road over Guadalupe creek has been awarded to M. E. Kilcourse for $6840.——Contract for furnishing crushed rock for several roads has been awarded to R. H. Jamison for $1.40 per cu. yd.——Bids will be received until 11 a.m., October 4, by H. A. Pfister, county clerk, for construction of reinforced concrete bridge on Payne avenue over San Tomas Aquino creek.

SAN LUIS OBISPO—Contract for construction of steel bridge over Paso Robles creek has been awarded to Gutleben Bros., New Call Bdg., San Francisco, for $11,773.——All bids for reclamation and bank protection work on Santa Maria river were rejected. The lowest bid was $14,480. A. F. Parsons is county surveyor.

SAN MATEO—William Toepke has prepared plans for municipal resort at Coyote Point. Bond issue for $30,000 is proposed.

SAN RAFAEL—Richmond-San Rafael Ferry & Transportation Co. will construct electric line to Point San Quentin. C. E. Van Damme, 5th and Channel streets, San Francisco, is interested.——Marin municipal water district has voted bonds for $3,000,000. This will provide funds for the purchase of property of North Coast Water Co., supplying Mill Valley, Tiburon, and Belvedere; and of Marin Water & Power Co., supplying San Rafael, San Anselmo, Fairfax, Corte Madera, Ross, and San Quentin. The latter company also sells water to the city of Sausalito. Bonds will also provide for the purchase of additional water-shed area, and for extensions to system.——County will spend $15,000 on Sausalito-Willow Camp road, $10,000 on San Rafael-McNear's Point road, and $10,000 on road from Inverness to Olema.

SANTA ANA—Contract for improving Hiatt street and La Mirada avenue in La Habra, and 5th street in Brea has been awarded to Max L. Hubermann, at the following unit-prices: 4000 cu. yd. excavation at 30c., 8200 lin. ft. shaping roadbed at 8c., 45 cu. yd. class A concrete in structures at $10, 1695 cu. yd. concrete in pavement at $1.925, 14 lin. ft. 30-in. concrete pipe, at $2, 174 lin. ft. 36-in. concrete pipe at $2.50, 30 lin. ft. 24-in. corrugated pipe at $2.50, and 2560 lb. reinforcing steel at 5c., a total of $6234.87. Engineer's estimate was $6533.85. Other bidders were H. M. Hanawalt, $6139.45; Oscar Ford, $7090.60; Brashear-Burns Co., $7467.25; Rogers Bros. Co., $7591.15.

SANTA BARBARA—Bonds for $1,000,000 for construction of county highway system has been defeated, also bonds for erection of county hospital and of detention home. Bonds for $350,000 for construction of bridges on state highway have been approved.——Construction of three blocks of pavement on Grand avenue is contemplated. Bids will probably be received up to October 21.——Construction of two blocks of pavement is contemplated. Bids will probably be received until November 4. A. B. Cook is city engineer.——Bond issue for construction of county highway system and other improvements has been defeated.——Contract for improving Canal street has been awarded to A. L. Pendola for $1.25 per lin. ft. for combined curb and 3-ft. gutter of concrete.——Contract for construction of wooden bridge over Salsipuedes creek on San Julian road has been awarded to E. F. Edwards for $1480.——Contract for improvement of Alameda Padre Serra has been awarded to L. L. Pendola for $4400.

SANTA CLARA—Bond issue for $85,000 for street improvements has been proposed. H. B. Fisher, San Jose, is town engineer.

SANTA CRUZ—City council has passed resolution of intention to construct concrete pavement, concrete waterways, sewers, manholes, and sidewalks on several streets. W. J. Thompson is city engineer.——Construction of county highway system costing $600,000 is proposed. Whether to raise funds by bond issue or by direct tax-levy has not been decided. E. J. Kelly, Watsonville, and R. L. Cardiff, Santa Cruz, are interested.

SANTA PAULA—Contract for construction of concrete bridge over Fagan barranca has been awarded to W. E. Jones for $839.

SAUSALITO—Contract for construction of electrolier system for about one mile of street has been awarded to Pacific Fire Extinguisher Co., 507 Montgomery street, San Francisco, for $41.80 per one-light electrolier, with compressed steel standard, or $2717 in all. Conduits have already been laid, but price includes connection with same. Other bidders were Globe Electric Co., $3970; Newberry Electric Co., $3712.20; Contra Costa Construction Co., $4485; McFell Electric Co., $5265; H. W. Johns Manville Co., $3916.25. L. L. Hohl is town engineer.

SOUTH PASADENA—John M. Gardiner, 518 Byrne Bdg., Los Angeles, was low bidder and will probably be awarded the contract for furnishing and laying the following wrought-steel standard screw-pipe: 4900 lin. ft. of 8-in. pipe at $1.045 lin. ft. of 6-in. at $0.72, and 825 ft. of 4-in. at $0.49. Pipe is to be laid with an average cover of four feet.——For furnishing two sewage ejectors, operating against a static head of 50 ft., and with a capacity of 50 gal. per minute, and including air-compressor, motor, and air-storage tank, R. W. Sparling, 945 North Main street, Los Angeles, was low bidder at $1880. No award has been made.

STOCKTON—Contract for construction of concrete curbs and gutters on Weber avenue has been awarded to E. Bishop for $1509.88.——Contract for construction of pavement on several streets has been awarded to Clark & Henery Construction Co. for $20,267.82.——Contract for construction of asphaltic macadam pavement on East Market street has been awarded to Ransome-Crummey Co., First Savings Bank Bdg., Oakland, for $26,025.25.——Contract for improvement of Weber and Murphy Ferry roads and West lane has been awarded to Cy Moreing & Sons for $23,512.——Contract for improvement of Jack Tone road has been awarded to C. W. McIntyre for $11,000.

SUSANVILLE—Work on Cowhead Lake irrigation project will commence about October 1. Charles A. Gardner and J. Dill are interested.

TROPICO—Contract for improving Green street has been awarded to J. H. Shafer for 3.09c. per sq. ft. for macadamizing, 67c. per lin. ft. for grading, and 7.9c. per sq. ft. for construction of sidewalks.

TULARE—City council has authorized property-owners to enter into contracts with the Federal Construction Co., Sharon Bdg., San Francisco, for the construction of pavement for 12½c. per sq. ft. for pavement with 5-in. concrete base and 1½-in. topeka top, 1c. per sq. ft. for grading, and 40c. per lin. ft. for curbing.

TURLOCK—Special assessment of $200,000 has been voted in Turlock irrigation district. Money will be used for operation, repairs, and extensions.

VENICE—Contract for improving Venice boulevard has been awarded to J. D. Kneen Contracting Co., Santa Monica, for 22.4c. per square foot.

VENTURA—Contract for construction of south abutment to Saticoy bridge has been awarded to Putnam-Stone Construction Co. for $10,811. This work includes 600 cu. yd. concrete, 19,100 lb. steel, 752 sq. ft. sheet steel piling, and 20 concrete piles, 35 ft. lower.——Contract for construction of bridge on state highway over Conejo creek has been awarded to Munoz & Munoz, Central Bdg., Los Angeles, for $7733. This work includes 456

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cu. yd. concrete, 47,100 lb. reinforcing steel, and 480 lin. ft. pipe railing.——Contract for construction of culverts in Saticoy road district has been awarded to A. Pefley, Nordhoff, for $4700.——Plans are being prepared by C. W. Petit, county surveyor, for a steel and timber bridge of 150-ft. span, with concrete piers and abutments at La Crosse. Estimated cost is $10,000. Work will probably be undertaken about November 1.——Bids will also be received until 2:30 p.m., October 8, for construction of two 3 by 10-ft. reinforced concrete culverts and 200 ft. of timber pile jetties.——Bonds for $1,000,000 for construction of county highway system have been voted.

VINA—Chico Construction Co., Chico, has been awarded contract for construction of three-mile irrigation ditch on Stanford ranch.

VISALIA—Board of supervisors has approved the formation of the Lindsay-Strathmore irrigation district. Works will provide for the storage of flood-waters on several streams and the expenditure of $2,000,000.——Coates & Traver, Fresno, have prepared plans for municipal auditorium. Estimated cost is $35,000.——Bids will be received until 8 p.m., October 6, by city clerk, for construction of sewer extensions involving 22,000 lin. ft. of 6-in. vitrified pipe, 4385 lin. ft. of 8-in. pipe, 1900 lin. ft. of 10-in. pipe, 14,000 lin. ft. of 30-in. concrete or brick sewer, 60 manholes, and 12 flush tanks. Plans from L. E. McCabe, city engineer.——Contract for construction of concrete bridge over Kings river on state highway has been awarded to Johnson Bros., Kingsburg, for $15,680. Turner Co. bid $14,333, but their bid was rejected.

WILLIAMS—Board of supervisors has appropriated $1500 for paving streets in connection with State highway work.

WOODLAND—City trustees have passed resolution of intention to construct 350,000 sq. ft. of warrenite pavement on bituminous base. Additional street-work will probably be done on the completion of these improvements. C. E. Arnold is city engineer.——Work will probably be started about November 15.

YUBA CITY—Construction of bridge over Feather river at Nicolaus has been proposed. Bridge will be 600 ft. long and cost $60,000. It has also been proposed that the county appropriate $75,000 toward construction of $150,000 bridge across Sacramento river at Grimes, for which county of Colusa has already appropriated $75,000.——Contract for construction of drainage canal for Sutter drainage district has been awarded to F. D. Groh.

OREGON

BAKER—Contract for construction of concrete substructure for Myrtle Street bridge has been awarded to Gilmore & Ritchie for $866.50. Contract for construction of steel superstructure has been awarded to Coast Bridge Co., Railway Exchange Bdg., Portland, for $2135.

EUGENE—Eugene water board has decided to erect auxiliary steam plant for use in case of breakdowns of hydro-electric plant. Estimated cost is $50,000.

KLAMATH FALLS—Reclamation Service has commenced surveys for completion of Tule Lake project.

McMINNVILLE—Contract for construction of Sourgrass road has been awarded to Tillamook Bay Construction Co., Bay City, for $18,863.

MILWAUKEE—Bonds for $25,000 for completion of water-system have been voted.

NEHALEM—Contract for construction of municipal lighting system has been awarded to West Coast Electric Co., Tillamook.

PORTLAND—Following bids have been received for construction of street pavements: asphaltic concrete, $1.35 to $1.47 per sq. yd.; asphaltic concrete on crushed rock base, $1.10 per sq. yd.; asphaltic concrete on concrete base, $1.40 to $1.62 per sq. yd.; class A hassam, $1.20 to $1.30 per sq. yd; bitulithic, $1.39 to $1.85 per sq. yd; bitulithic on crushed rock base, $1.38 to $1.85; sheet asphalt on concrete base, $1.55 to $1.59 per sq. yd.; concrete, $1.20 to $1.35 per sq. yd.——Following bids have been received for paving Schiller street: Warren Construction Co., bitulithic on crushed rock base, $1.85 per sq. yd.; asphaltic concrete on concrete base, $1.62 per sq. yd.; Oskar Huber, bitulithic on crushed rock base, $1.34 per sq. yd.; Oregon Hassam Paving Co., class A hassam, $1.35 per sq. yd.——Contract for construction of second story of municipal boat-landing has been awarded to J. A. Backstrand, Chamber of Commerce Bdg., for $12,150.——Contract for furnishing four boilers for steamer 'Rose City' has been awarded to Ballin Water-Tube Boiler Co., Worcester Bdg., for $50,000.——Bids will be received until 11 a.m., October 7, by U. S. Engineer Office, for furnishing cement.——Work will soon be started to eliminate grade-crossings on Oregon-Washington Railroad & Navigation Co.'s tracks within city. J. R. Holman is chief engineer. Estimated cost is $750,000.

ROSEBURG—Construction of railroad to Umpqua National forest, which is to be built jointly by city and by Kendall Bros., Pittsburg, Pennsylvania, will commence soon. C. L. Selecman is local representative.

SALEM—State highway commission has authorized the expenditure of $30,000 of state funds on Columbia River highway in Columbia county at Rainier hill, and the county will appropriate an additional amount sufficient to put road in good condition. Contract for work has been awarded to Standifer-Clarkson Co., Portland, Oregon.

WASHINGTON

AUBURN—Mattson & Carlson were low bidders at 95c. per sq. yd. for construction of pavement having 5-in. concrete base and 1½-in. asphaltic top. Ferch & Gass were low bidders at 98c. per sq. yd. for two-course concrete pavement. Washington Paving Co., Savage-Scofield Bdg., Tacoma, bid $1.47 per sq. yd. for 5-in. concrete base and 2-in. bitulithic top. The latter concern was awarded the contract.

BELLINGHAM—Bellingham, Mt. Baker & Spokane railroad has awarded contract for construction of railroad to Spokane, a distance of 228 miles, to E. J. Fader, New Westminster, B. C.

BREMERTON—Contract for street improvements has been awarded to E. H. L. Morris, Seattle, for $8558.41.

CATHLEMET—Contract for grading and draining 4½ miles of State road No. 9 has been awarded to O. S. Dosland, Gray River, for $8000.

EVERETT—Bonds for $1,700,000 for purchase of water-system and extensions have been voted.——Contract for construction of pavement 30 ft. wide on Rucker street has been awarded to Bancroft & Morgan for $30,717.

KELSO—Contract for construction of 400-ft. jetty has been awarded to Interstate Construction Co., Portland, Oregon.

LA CONNER—Contract for construction of concrete pavement on several streets has been awarded to N. W. Ball, Seattle, for $13,987.25.

NORTH YAKIMA—Contract for grading 6½ miles of road in Selah valley has been awarded to Thomas Dingle for $12,702.64. Contract for hard-surfacing 1¼ miles of Nob Hill boulevard has been awarded to Cascade Construction Co. for $5170.

OLYMPIA—Contract for surfacing road between Ashlock and Francis with crushed rock has been awarded to K. L. Goulter, Sea View, for $1.84 to $1.99 per cu. yd.——Contract for construction of three miles of state highway from Union Flat creek south, in Whitman county, has been awarded to H. C. Root, Spokane, for $77,883.70.——Contract for clearing, grading, and draining seven miles of state highway from Nemah to Nasel, in Pacific county, has been awarded to Burnett Construction Co., Seattle.——Contract for gravel-surfacing 10 miles of state highway from Mineral to Morton, in Lewis county, has been awarded to Torger Peterson, Eatonville, for $23,400.——State highway commission will receive bids until October 11, for grading, draining, and surfacing seven miles of highway between Waitsburg and Dayton, and gravel-surfacing 17 miles of highway between Colfax and Rosalia.——Herman Mallory will build wharf and derrick.——Oregon-Washington Railroad & Navigation Co. will commence laying rails on newly-completed grade between Point Defiance and Olympia.

PULLMAN—Contract for laying concrete sidewalks in College Hill district has been awarded to Mitchell Bros. & Payne, Spokane, for $15,265.——Contract for laying 1700 lin. ft. of sewer pipe has been awarded to James C. Broad, Spokane, for $1487.

SEATTLE—Reitze, Storey & Duffy, Northern Bank Bdg., are preparing plans for several distributing stations for Shell Oil Co., including one at Edmonds, B. C., costing $100,000, besides the enlargement of several existing plants.——Contract for grading and filling on Alki avenue has been awarded to Puget Sound Bridge & Dredging Co., Oriental Bdg., for $93,250.——Contract for construction of asphalt pavement on 6th avenue South has been awarded to F. McLellan, Globe block, for $29,680.40.——Contract for paving on 5th avenue North and 16th avenue South has been awarded to P. J. McHugh, 3rd and Mercer streets, for $29,111.05.——Contract for bulkheading and other timber work in connection with the improvement of Alki avenue has been awarded to J. A. McEachern Co., Bell Street dock, for $50,000.——Bids are being received by trustees of Masonic Temple for construction of building. Estimated cost is $150,000. George W. Lawton is architect.——City bridge engineer Rapp is preparing plans for bridge over Lake Washington canal at 10th avenue. Bids will probable be called for about November 1.

TACOMA—Contract for surfacing permanent highway No. 7, for a distance of 3.7 miles with a 2-in. course of warrenite has been awarded to Washington Paving Co., Savage-Scofield Bdg., for $32,243.——County commissioners have authorized T. H. White, county engineer, to make survey for 10.6 miles of hard-surfaced road. It is hoped that construction can be started before the end of the year. Estimated cost is $100,000.——Contract for paving 5.57 miles of highway with 5-in. concrete base and 2-in. bitulithic surface, has been awarded to Washington Paving Co., Savage-Scofield Bdg., for $70,375.

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VANCOUVER—City clerk will receive bids until October 4 for improvement of Columbia street, from 3rd to 12th streets.——Construction of 8-in. lateral sewers on Esther street and on alley near 21st street has been proposed.——Contract for construction of bitulithic pavement and concrete walks and curbs on Columbia street has been awarded to Vancouver Construction Co. for $5036.

WALLA WALLA—Contract for construction of $250,000 hospital has been awarded to Beezer Bros., Northern Bank Bdg., Seattle.——Contract for construction of two blocks of gravel bitulithic pavement on 12th street has been awarded to Warren Construction Co., Portland, for $2176.

WATERVILLE—Contract for construction of permanent highway No. 3 has been awarded to Bailey & O'Connor, Wenatchee, for $17,985.

WENATCHEE—Bond issue of $500,000 has been authorized in Wenatchee reclamation district for purchase of canal and extensions.——County commissioners of Chelan county will spend $8000 on improvement of Blewett Pass road.

Engineering Societies and Conventions

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Charles McGonigle, president, care Western Sheet Metal Works.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

San Francisco Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. F. W. Gay, secretary, care J. G. White & Co., Alaska Commercial building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, secretary, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. W. K. Barnard, secretary, 701 Central building, Los Angeles.

Coming Conventions

AMERICAN BUILDERS' WEEK, San Francisco, October 18-23. E. T. Thurston, secretary, 57 Post street, San Francisco.

AMERICAN PETROLEUM SOCIETY, San Francisco, October 25-30. Irving C. Allen, secretary, 506 Custom House, San Francisco.

AMERICAN ELECTRIC RAILWAY ASSOCIATION. San Francisco, October 4-9. E. B. Burritt, secretary, 165 Broadway, New York.

Personal

A. KEMPKEY, consulting engineer, has moved his offices to the Hobart Bdg., San Francisco.

JAMES W. REAGAN has been appointed engineer for the Los Angeles county flood-control districts.

JOHN H. WHISTLER, engineer for the United States Reclamation Service, is investigating irrigation projects in the vicinity of Medford, Oregon.

G. G. HALL, city engineer of South Bend, Washington, has been engaged by Tillamook county, Oregon, as consulting engineer on the highway paving now being done in that county by the Arenz Construction Co., Salem, Oregon.

PAUL P. WHITHAM, consulting engineer of Seattle, has been in San Francisco and Los Angeles on professional business. While in Los Angeles, he addressed the conference of the American Association of Port Authorities on the subject of Port-Terminal Development.

B. F. WADE, hydraulic engineer, has joined the staff of the Redwood Manufacturers Company with headquarters in the Hobart building, San Francisco. Mr. Wade will confine his attention to the design and construction of wood-stave pipelines for power, irrigation, and water-supply purposes.

The Los Angeles section of the American Society of Mechanical Engineers has elected the following officers for the coming year: chairman, W. W. SMITH; vice-chairman, W. A. E. NOBLE; secretary, FORD W. HARRIS. The executive committee is composed of the officers named, together with O. J. ROOT and F. C. FINKLE.

The American Highway Association has elected the following officers for the coming year: FAIRFAX HARRISON, Washington, D. C., president; L. W. PAGE, Washington, D. C., vice-president; JOHN BURKE, Washington, D. C., treasurer; T. J. MEHERN, New York, JAMES H. MCDONALD, Connecticut, GEORGE W. COOLEY, Minnesota, JOSEPH HYDE PRATT, North Carolina, HENRY C. SHIRLEY, W. T. BEATTY, Illinois, and R. C. KENYON, Indiana, directors.

The following officers were elected for the coming year by the International Irrigation Congress: RICHARD F. BURGES, El Paso, Texas, president; J. S. DENNIS, Calgary, Canada, first vice-president; GEORGE A. SMITH, Salt Lake City, Utah, second vice-president; L. A. NARES, Fresno, California, third vice-president; K. GLUMWALD, Denver, Colorado, fourth vice-president; L. CLAPP, Hatch, New Mexico, fifth vice-president; ARTHUR HOOKER, Spokane, Washington, secretary.

The following officers have been elected by the League of California Municipalities: ALLEN H. WRIGHT, San Diego, president; WALLACE RUTHERFORD, Napa, first vice-president; LORIN A. HANDLEY, Los Angeles, second vice-president; H. A. MANSON, San Francisco, and W. J. LOCKE, Alameda, secretaries. JAMES E. SUTTON, city engineer of Alameda, has been elected president and B. E. CRONKHITE, city engineer of Fresno, secretary of the department of engineers, councilmen, and street superintendents.

Obituary

MAX HEBGEN, vice-president and general manager of the Montana Power Co., died at Chicago, August 24.

T. B. TWADDLE, for many years chairman of the board of supervisors of Tulare county, California, and noted as a builder of oiled roads, died at Santa Cruz, August 31.

Commercial Paragraphs

The KROGH MANUFACTURING CO., of San Francisco, recently sold 40 centrifugal pumps to the Anaconda Copper Mining Co., of Montana.

The GENERAL MACHINERY & SUPPLY CO., of San Francisco, has been awarded a gold medal for its improved compressor exhibited in 'The Mine' at the Panama-Pacific Exposition.

The WATERLOO CEMENT MACHINERY CO. of Waterloo, Iowa, has received a gold medal for its exhibit of Wonder Mixers and the Wonder Paver at the Panama-Pacific Exposition. The company has also received a gold medal for a similar exhibit at the Panama-California Exposition at San Diego.

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